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Preface

One of two themes for the forthcoming ***World Food Summit: five years later (WFS:fyl)*** is ***Mobilizing Resources to Fight Hunger***. FAO is concerned that investment in agriculture continues to decline instead of growing as demanded by the World Food Summit in 1996. The incremental requirements of agricultural investment in developing countries are estimated at US$30.7 billion per annum – of which approximately one-third is needed for irrigation. The evidence suggests, however, that agricultural investment has progressively declined rather than increased. For instance, the share for agricultural lending in the loan portfolio of The World Bank fell below 10 percent in the year 2000 compared with 40 percent 30 years ago. One possible cause for declining investment in agriculture might be the historically poor performance of such investments and the non-recognition of their secondary benefits. There is also a shift from public to private investment which does not fully compensate the decline.

FAO is therefore striving to reverse the trend of declining investment and to draw attention to the fact that investment in Land and Water is a good investment, if managed properly. For this purpose, the Regional Office for Asia and the Pacific in close collaboration with the Land and Water Development Division in FAO Headquarters organized and conducted the Regional Consultation on Investment in Land and Water. Its objective is to raise awareness and to enlist and enable the support of partners and member countries to attain enhanced commitment and innovation to finance sustainable agricultural development and food security.

The consultation was held in FAO's Regional Office for Asia and The Pacific in Bangkok, Thailand, from 3 to 5 October 2001. High level government officers from 12 countries in the region participated together with observers from the Asian Development Bank, the International Water Management Institute (IWMI), the Mekong River Commission (MRC) and various Thai government agencies.

This publication contains the papers presented at the meeting as well as the highlights and recommendations for enhanced investment in Land and Water which resulted from the group and plenary discussions. The Consultation adopted the ***Bangkok Declaration*** which urges Heads of State and Ministers of agriculture, rural development, planning and finance in the region to alert and motivate the necessary political will and investment commitment, to form policies and take initiatives to create an enabling environment for sustainable land and water management and advances in agriculture and rural development leading to comprehensive food security.

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Summary report, highlights and recommendations

BACKGROUND

One of the two themes for the forthcoming ***World Food Summit: five years later*** *(WFS: fyl)* is *Mobilizing Resources to Fight Hunger*. FAO is concerned that investment in agriculture continues to decline instead of growing as demanded by the World Food Summit in 1996. The Land and Water Development Division at FAO Rome therefore initiated a process to enlist and enable the support of essential partners to attain enhanced commitment and innovation to finance agriculture and food security. The Regional Consultation on Investment in Land and Water conducted by the FAO Regional Office, Bangkok is a part of this process, to highlight the crucial importance of this theme for regional food security.

Arrangements and participation

The Regional Consultation was held from 3 to 5 October 2001 at the FAO Regional Office for Asia and the Pacific (RAP) in Bangkok, Thailand.

In his opening address, R.B. Singh, Assistant Director-General and FAO Regional Representative for Asia and The Pacific, highlighted the present situation and the prospects for food security, production and poverty in the region. He reported on the status of investment in land and water, future needs and investment mechanisms and on a required policy framework for investment in land and water towards sustained food security and prosperity. He emphasized the need for an integrated approach to land and water management, called for an investment strategy and stressed the need for a flexible and participatory approach to capture the new technological, management and development opportunities by increased investment in land and water conservation, improvement and utilization. He called upon each nation to adopt and implement a national vision on investment in land and water.

The three-day meeting accomplished the following activities:

- summary presentation of resource papers;
- summary presentation of country specific reports from 12 countries in the region;
- group discussions (two groups) on selected topics;
- preparation of conclusions and recommendations and discussion in a final plenary session; and
- preparation, discussion and adoption of the **Bangkok Declaration on Investment in Land and Water** as an essential input to the statements by country level delegations which will participate in *WFS: fyl*.

The Declaration immediately follows this summary. The agenda is given in Annex I; participants are named in Annex II.

High level government officers from 12 countries attended the Consultation: Bangladesh, Cambodia, China, Democratic Peoples' Republic of Korea, India, Indonesia, Laos, Pakistan, Republic of Korea, Sri Lanka, Thailand and Viet Nam. In addition to FAO, representatives of international organizations such as the Asian Development Bank, the Mekong River Commission (MRC) and the International Water Management Institute (IWMI) attended as observers.

HIGHLIGHTS AND RECOMMENDATIONS

Highlights

Land and land quality

The total land area of the Asia and the Pacific region is 3 001 million ha or 22.9 percent of the world's land area. However adverse soils, climate and topographic factors limit the possibilities for sustainable agricultural production in about 86 percent of the region.

The consultation concluded that loss of potential soil productivity due to erosion and soil nutrient depletion, with an increasing net negative balance in the soil is the biggest threat to meeting the region's future agricultural needs. Furthermore loss in soil productivity in both the commercial and subsistence sectors causes high additional national costs, such as increased food imports, reduced exports and higher social welfare costs for those who fall below the poverty line.

Land and water investment decisions also have serious implications for global warming and climate change. The potential for carbon sequestration in soils may be as high as 40 percent of the total annual atmospheric increase in CO_2 concentrations, which may be increasingly tapped through multiple cropping and alternate multiple land use systems. Water management practices can greatly impact methane emission from paddy fields – an important point of consideration for Asia and the Pacific region, as about 90 percent of world's rice lands are here.

Scarcity of land and water

The consultation recognized the crucial role of intensified utilization of land and water resources for ensuring food security, poverty alleviation and broad-based rural development. Estimates show that between 1997 and 2030, about 80 percent of projected crop production growth in developing countries will come from intensification as higher yields (69 percent) and cropping intensities (11 percent), with only 20 percent coming from arable land expansion. The share resulting from intensification will exceed 95 percent in land-scarce South, Southeast and East Asia.

Similarly in the water sector, by the year 2025, 48 countries with a population of more than 1.4 billion persons will face water stress and scarcity. The per capita water availability in Asia decreased from 9.6 to 3.3 km^3/year between 1950 and 2000. Increasing water scarcity will result largely from rapidly growing demands for agricultural, industrial and household purposes. Degradation of irrigated land due to waterlogging, deterioration of water quality, upstream land degradation, seasonal flooding and insufficient river flow will aggravate water shortage problems. The consultation viewed with concern the threat to agricultural production due to the water shortage: it is of particular concern because this sector accounts for 80 percent or more of total fresh water use in these countries.

Land improvement in less favoured rainfed areas

Farming systems in less favoured areas dominate mixed farming and other practices that contribute to soil, nutrient and water conservation. Hence major productivity improvements will have to come from improved natural resource management practices, technologies for conservation tillage and integrated watershed development.

Integrated watershed development has become the preferred approach for developing rainfed areas in many Asian countries with the twin objectives of resource conservation and development. Apart from direct benefits to the participants, the impact extends in terms of domestic production, enhanced food security, reduced market fluctuations, income and employment generation and foreign exchange savings.

Low and declining investment in agriculture

The already low and further declining trends in investment in agriculture through both domestic and external resources in most of the countries are matters of great concern. When measured in constant 1995 price, official development assistance from bilateral and multilateral donors is 8 percent below 1990 levels. The proportion of sectorally allocable aid reaching agriculture, forestry and fisheries fell to 20 percent in 1987-1989 and then to 12.5 percent in 1996-1998. In financial year 2000, World Bank lending for agriculture and rural development was its lowest ever in both percentage terms and absolute amounts. Current levels of foreign aid at 0.24 percent of annual GDP, fall short of the 0.7 percent target set by developed aid-donor countries. Actual aid falls short of that target by US$100 000 million a year. The share of agricultural lending in the loan portfolio of the World Bank fell below 10 percent in 2000, as against 40 percent 30 years ago. The World Commission on Water considers investment levels to be less than half of that needed (about US$180 million per year) to meet minimum water, sanitation and nutrition requirements in developing countries by 2025. Recent studies indicate that the allocations for irrigation schemes and operation and maintenance are less than 50 percent of what is required.

It should be recognized that investment in land or water development is not just an investment in one item – it entails a chain reaction of investing in a whole range of elements such as farming practices, plant varieties, nutrients, human resources, the broader infrastructure and conducive policies. The Governments are committed to equity-led development goals. In order to enable land, water and labour resources to make their full contribution to achieve these goals, it is necessary to continuously enhance their productivity. This will not simply happen without increased investment in land and water development and associated policy reforms for realizing their full benefits and returns.

Investment requirements

Investment requirements can be grouped into two interdependent categories: the monetary requirement and the human resource and attitudinal requirement. Land intensification needs may generally encompass investments for:

- soil fertility maintenance by adequate levels of balanced fertilization and management of the structural, textural and organic health;
- land shaping for adoption of minimum tillage and other land operation practices;
- soil conservation and afforestation measures;
- reclaiming acid, saline, alkali soils, ravine areas, stabilizing sand dunes, waterlogged and other such degraded land; and
- enriching the biological health of soils.

Likewise, investments in water resources, supply and use are required for:

- design and construction of large, medium, small and micro irrigation schemes;
- rehabilitation, upgradation and modernization of existing irrigation schemes and systems;
- developing new and tapping unutilized water resources;
- developing river basin-based integrated development and management of water;
- prevention of water pollution and deterioration of water quality; and
- integrated watershed development encompassing upgradation of arable land, non-arable land and underground water, particularly in rainfed areas in arid and semi-arid zones.

Returns on investment in irrigation

A World Bank study of 208 World Bank funded irrigation projects implemented and evaluated between 1950 and 1993, with loans of US$31 billion, indicated comparable satisfactory rates for agriculture as a whole and an all-project average of 65 and 76 percent respectively. The internal rate of return (IRR) for agriculture as a whole was 13 percent and the all-project average was 16 percent. Weighting irrigation projects by area served raises their average IRR to 25 percent with 84 percent of the projects rating satisfactory.

Private investment provides all financing for about 20 percent of the total area currently irrigated. The share of private investment in the remaining 80 percent is approximately half of total investment.

The high population absorptive capacity of irrigation limits the migration of growing populations to areas of greater environmental risk. If additional water for irrigation – 17 percent by 2025 – is not forthcoming, the increased burden on rainfed agriculture to meet demand will be enormous and more detrimental to the environment with far more land clearance than at present.

Producing more rice with less water is a formidable challenge for the food, economic, social and water security of Asia. A comprehensive reform package is needed for improving the performance of rice irrigation systems. The FAO estimate for increased irrigation efficiency in developing countries calls for a rise from 43 percent in 1995/1997 to 50 percent by 2030. This means investing in generation of water saving technologies and practices and their extension, maximizing returns from both water and land.

Expansion of irrigated area

Between 1961 to 1963 and 1995 to 1997, irrigated areas in developing countries increased at an annual rate of 1.9 percent to about 197 million ha, representing three-fourths of the world's irrigated area, of which 74 percent is in Asia. Asia registered the largest increase with 70 million ha in India, Pakistan and China. However, the area of irrigated land is predicted to increase by 0.6 percent per annum to 242 million ha in 2030. Declining and insufficient investment in agriculture and water sector reflect this decreasing trend in irrigation expansion. This trend does not augur well for meeting the expected food demands in the future and should be reversed.

Irrigation sector reforms

Irrigation sector reforms should be part of a more general reform of water resource management, in which issues of water allocation, water rights, ownership of transferred assets and financial management of operation and maintenance of the irrigation systems are addressed. Wrong incentives such as poorly targeted subsidies or inappropriate water pricing systems can induce overuse or wastage of water and eventual groundwater depletion and deterioration of water quality.

Participatory irrigation management (PIM) and irrigation management transfer (IMT)

In Asia, where older public sector irrigation schemes are more than a few decades old, the issue of rehabilitation, which is related to those of operation and maintenance and modernization, is becoming increasingly important. Initial system designs may represent a severe constraint to the adoption of new and more flexible operational procedures required for present and future service requirements. Merely restoring the systems to their initial state will not be sufficient. Appropriate Participatory Irrigation Management (PIM) and Irrigation Management Transfer (IMT) reforms can be instrumental in ensuring that the systems are responsive to farmers' needs. The new ideas about decentralized irrigation improvement funds exemplify "smart subsidy schemes" that encourage investment by water users in maintaining and upgrading their schemes. Privatization of minor irrigation in Bangladesh models how policy liberalization accompanied by technical support can promote increased smallholder investment in irrigation and better management. Small-scale irrigation schemes can implement efficient and flexible distribution and management regimes.

Rural micro-credit institutions

Governments and international donors have generally avoided investment in reforming rural financial systems and developing credit facilities for small farmers with little or no collateral. Uncertainty of land tenure is a deterrent to long-term and sustainable investment in land. Ambiguities relating to rights of land, water and trees contribute to environmental degradation and curb investment desires. Other institutional aspects include the absence of clear community mechanisms for upkeep of public assets and infrastructure, lack of financial services and the marginalization of women. The absence of microcredit institutions discourages investment in soil and water conservation measures, particularly if payback periods are relatively long. There is an urgent need to foster the growth and viability of rural microcredit institutions.

RECOMMENDATIONS

Political will and investment commitment: Economic recession in the 1990s, coupled with globalization leading to structural adjustment programmes, has constrained national resource devolution for land and water investment programmes which will adversely affect production prospects in the future. Donor priorities in lending for infrastructure and social sectors have changed, further compounded the problem. However, intangible gains, positive externalities and environmental payoffs resulting from land and water development projects must be recognized. Synergies with other rural development programmes which can be exploited and maximized demand increasing levels of investment.

With this background, the consultation appealed to Asia-Pacific Heads of State (and to ministers of agriculture, rural development, planning and finance) to alert and motivate their countries' political will and investment commitment to form policies and take initiatives in due proportion to urgency of sustainable natural resource management, to create an enabling environment for advances in agriculture and rural development. The Consultation called upon Heads of State and Ministers to forge and enable public and private sector cooperation in investment and peoples' participation in planning and implementation. Such cooperation would focus on watershed and river basin development; integrated land, water and irrigation management; infrastructural and institutional strengthening and market reforms, human resource development (for generating, adapting and transferring technologies and equity- and gender-sensitive approaches to increasing and diversifying national and regional agricultural economies) to inaugurate a sustainable Asia-Pacific Ever-Green Revolution.

Economic policies: Arising from this political will and commitment to investment, suitable economic policies must be framed and an enabling environment created to ensure a fair return to cultivators, which in turn encourages their investment in land and water. Such policies may provide more

incentives to the private sector, credit-linked beneficiary investment schemes, direct release of funds to watershed development implementing agencies, decentralization and the devolution of power. They should also include finance management, operational transparency, collective decision-making, targeted and structured subsidies, community-managed revolving funds, viable water use associations, cost sharing and community level support for higher quality first stage agricultural processing activities, land rights and entitlements. The need for congruence and coherence among concerned sectoral policies was emphasized.

Priority land and water sector programmes included: conservation tillage, watershed development, small irrigation systems, groundwater development, improved lower level canal irrigation efficiency, conjunctive use of surface and groundwater, promotion of land consolidation against fragmentation and institutional capacity building. The Consultation recognized that improved irrigation system efficiency, faster groundwater exploitation through aquifer management and land and water management in difficult agro-economic regimes requires greater involvement of farmers and community organizations. The Consultation noted that in many countries such "small projects" are already priorities and need more support, through organizational and financial reforms, for faster replication.

The Consultation observed that irrigation project development costs have risen significantly in the recent past and therefore the benefit in terms of area coverage is not increasing in proportion to investment. It recommended that high priority may be assigned to complete the pending projects at the earliest to avoid cost overruns and time overruns and to derive the benefits in a cost effective way. The magnitude of this situation as occurring in India and other countries needs to be redressed by enhanced investment.

Comprehensive country specific reform packages are needed to improve irrigation system performance. Irrigation Management Transfer (IMT) programmes often have budgets too small for institutional development, training and capacity building. This may constitute a threat to the sustainability of water user associations after IMT implementation and must be reflected in IMT instruments.

Small-scale irrigation schemes can bestow efficient flexible distribution and management regimes. Their limitations include no outside urgency to bear risk, lack of financial or borrowing capacity, uneconomic irrigation design and management. In such schemes much higher investment by the beneficiaries may be promoted.

Over-extraction of groundwater is widespread and caused by industrial, domestic and agricultural withdrawals. In substantial areas of China and India, groundwater levels are falling by 1-3 metres per year. Over-extraction in coastal areas causes ingress of saltwater into freshwater aquifers. The Consultation recommended that investment in groundwater utilization must be based on water balance and recharge data of the area and the spatial distribution of wells and pumps regulated accordingly.

The Consultation recognized the FAO Agro-ecological Zoning Methodology (AZM) as providing a broad framework for developing perspective national land use policy. Irrigation and water requirements must be systematically and scientifically assessed in the context of cultivable land availability, food and agricultural production goals and demand-supply balance. "Global" and "local" models for assessing these needs and prospects are available and can be further developed, which countries must be aware of and capable of using in their development planning exercise.

Land and water use planning and management: The consultation noted that more attention is needed to improve planning of land use and land management. Natural resources inventorying, efficient crop

zoning, land reclamation and soil fertility improvement, arresting the impact of land degradation processes involving integration across disciplines, ministries, farmer groups and NGOs is required to meet farmer-driven technology support for a diversified agricultural economy and sustained faster and more broad based rural development. Countries were urged to evolve a perspective national land use and water policy fully internalized in national agricultural policy with emphasis on conservation of fragile lands, restoration of problem lands and intensified production of good lands. Adequate investment must be mobilized for enabling community owned watershed development programmes and for environment-friendly integrated plant nutrient management programmes.

The Consultation noted that besides serious gaps in land and water management and priorities, there are serious conflicts between quick gains and long-term sustainability. Several successful experiences of land and water management with tremendous impacts on production, productivity, food security, poverty alleviation, income, trade, and sustainability exist in Asian and other countries. The Consultation recommended that FAO should critically document and share these experiences with Member countries. There are cases of failures as well, which should also be critically analyzed and the causes behind made known to avoid further failures.

The Consultation appreciated that many times local wisdom, indigenous knowledge and technologies have been highly effective in land and water management. But in the rush for quick fixes and due to the lack of vision and *perspectives*, these traditions and wisdom are dying. The Consultation recommended that management of investment in land and water must duly recognize the traditional knowledge, and blend them with modern technologies referred to as ecotechnology. The need for investing in people in shaping their attitude and participation can hardly be overemphasized. The people are the real guardians as service providers as well as beneficiaries, and hence the development must be rooted in the spirit of "of the people, by the people and for the people."

System-based research and technology development: Given the complexity of judicious development and use of land and water resources, the Consultation emphasized that not only agro-physical and agro-biological issues but also socio-economic, environmental and ecological issues should be considered in a system approach to ensure the congruence of enhanced productivity (efficiency), sustainability, profitability and equity. Only such an integrated holistic and system-based research and technology development approach will simultaneously satisfy the varied stakeholders, such as farmers, environmentalists (the "Green" lobby) and the wider public. Paradigm shifts are called for in research and development (R&D) to emphasize an interdisciplinary and multidisciplinary approach rather than monodisciplinary. Moreover, the process and not only the product, system-based and not just commodity-based, and people-and-environment-driven and not just technology-driven need to be emphasized. The Consultation recognized that such R&D systems are bound to be complex and demanding. Therefore, it is recommended that besides increasing R&D investments to meet the complex challenges, institutional supports and human resources should be adjusted for establishing and managing various linkages at national and international levels. For ensuring informed investment and management of the resources, suitable indicators should be developed by NARS, IARCs and FAO for ascertaining economic, environmental, ecological and social costs and benefits. Consequently, policy research capacity, including socio-economic research capacity, will have to be greatly strengthened in national and international land and water R&D programmes.

The Consultation suggested that research and technology development efforts in land and water sectors, backed up by adequate investment, should cover:

- mapping and use classification of land and water resources to improve the efficiency of land and water use in agriculture;
- policy, institutional, economic and social aspects of land and water management;
- design and operation of irrigation schemes;
- management of watersheds for multiple functions;

- management of aquatic ecosystems in particular those with boundaries with terrestrial ecosystem;
- wastewater recycling, conjunctive water use, improved water quality and reduced water pollution;
- restoration of fertility and structure of degraded lands and prevention of further degradation, bioremediation; and
- integrated soil-water-plant-nutrient management and fertility improvement.

In recent years, national and international agricultural research institutions (particularly CGIAR, the Consultative Group on International Agricultural Research based at the World Bank) have allocated increased proportions of their budgets to natural resources management. But, often it has happened at the cost of other equally important areas. Thus, there is a need for explicitly allocating additional funds to land and water resources commensurate with the priority. Their work programmes should clearly identify multidisciplinary and multi-institutional activities. Concerned institutions must have capacity to value natural resources and analyze environmental impacts – costs and benefits to justify as well as to monitor the efficacy of the investments. Because of multidisciplinary and multi-component technology packages and the emphasis on bottom-up and participatory approaches, the Consultation recommended that the extension and technology assessment and diffusion systems should be overhauled and suitably trained human resources should be developed to establish effective research-extension-farmer-market linkages. The Consultation recognized that the Asia-Pacific Region is the leader in development and widespread adoption of Integrated Pest Management (IPM) technologies, including the farmers' field school (FFS) initiative and recommended that FAO and NARS should use this experience in the investment and management of land and water resources. Indicators and methodologies such as those developed by the International Water Management Institute should be internalized in national natural resource management research (NRMR) programmes.

Database and information sharing: The Consultation noted that adequate, timely and reliable data on the state of land and water quality, degradation or improvement are generally not available. It observed that indigenous technologies and knowledge should form an integral part of databases. Public and private sectors should invest not only in necessary hardware and software but also in human resource training and development for collecting, collating and sharing information on land and water resources, recommended the Consultation. Soil and water clinics in rural areas should be linked with rural agricultural information centres which must constitute an integral part of the national agricultural information system. International organizations such as FAO, UNEP, CGIAR Centres – including IWMI and global and national Soil and Terrain Digital Database (SOTER) programmes – have established dynamic and comprehensive databases. National and international databases should be linked with these databases for deriving maximum mutual benefits. FAO should strive to harmonize various indicators, methodologies for environmental and ecological accounting and data collection formats for standardizing the information collection and interpretation procedures.

Integrated approach to investment in and development of land and water: The Consultation underlined that although two distinct and two most fundamental natural resources, not only for agriculture but for the very life and existence of the humankind, land and water are intimately interrelated resources. The extent, quality and productivity of the two resources are highly interdependent. Therefore, the Consultation emphasized that while there must be land-specific and water-specific conservation, development and utilization policies, strategies and programmes, there is a need to have clear policy and approach for synergistic development and effective integration of land and water to enhance overall productivity, sustainability, profitability and reduction of environmental costs. The Consultation recommended that, on the demand side, land and water policies must be reformed to promote land and water savings through demand management and application of appropriate technologies. Policy instruments for demand management may include: (i) enabling conditions through provisions of suitable land and water rights and laws to promote investment in and effective management of the resources, (ii) market-based incentives to promote conservation of land and water resources such as organic farming, appropriate pricing, reduced subsidies on urban water consumption and targeted taxes and subsidies, (iii) non-market instruments, including restrictions, licenses and pollution controls and (iv) direct interventions, including conservation programmes.

Rights to land and water: Secure rights to land and water and rights of access to these resources are essential for long-term investment by farmers in land and water conservation and improvement, as well as to enable the farmers to effectively participate in participatory planning, investment and management. The Consultation expressed concern that such rights have not been granted in several countries to the actual users and developers of the resources, and recommended that this gap should soon be rectified. Property rights for women farmers should be given due attention as the number of women-headed households are increasing. Local customs, needs and specifics should be kept in mind while strengthening the rights regime, which must have efficient conflict-resolving investment-friendly mechanisms.

Financing mechanisms: The Consultation noted that government services to farmers are being reshaped by decentralization of government services, with some reduction in quality of services. Governments are also involved in privatizing many services. These trends, along with the WTO settings are creating changed circumstances in which small farmers have to produce agricultural products and generate family incomes. The Consultation recommended that the impact of these changes on farmers and rural communities and future priorities for investment in the rural and agricultural sector should be analyzed. Besides identifying the priority areas for investment, it would be essential to analyze the various financing mechanisms and their linkages. These linkages must be managed in consistence with the appropriate rights and laws related to the resources and their transparent governance. *What is needed are new financing mechanisms, not criticizing the existing ones.*

The Consultation felt the need of a flexible, responsive and multi-directional financing mechanism. Country-owned poverty reduction strategies (CPRS) can be articulated to provide the basis for donor concessional assistance (particularly World Bank and IMF lending) and use of resources freed by debt relief enhanced under the highly indebted poor countries (HIPC) initiative. It suggested that the World Bank's Comprehensive Development Framework (CDF) or its equivalent the UN Development Assistance Framework (UNDAF) at the country level may form a basis for coordination around programmes and action plans based on the countries Poverty Reduction Strategy Paper (PRSP). The Consultation noted that of the 23 LIFDCs with the highest prevalence of undernourishment, 17 are in the HIPC group of eligible countries. Overall, 41 countries with US$170 billion in external debt are eligible for consideration under HIPC initiative. The enhanced initiative seeks to establish stronger link between debt relief and sustainable poverty reduction programmes in recipient countries.

With the above backdrop, the Consultation suggested that a 'flexible lending framework' should be evolved as a mechanism for implementing CPRS. In this mechanism, World Bank may take the lead in providing broad-based poverty reduction support credit (PRSC) linked to key objectives, reform areas and priority action areas such as land and water development. Governments will receive the credit on IDA terms geared to performance. The funding is integrated with the government budgetary cycle and augments the capacity to allocate resources on a cross-sectoral basis. In this process and facilitation, FAO has a role in assisting governments in articulating agriculture sector strategy and in the formulation of programmes within CPRS framework. This also provides scope for interested bilateral donors to enter into partnership with FAO to support such programmes.

The Consultation further suggested that while each country may evolve clearly defined rights to land, rights to water, and necessary laws, comprehensive and transparent agrarian reforms should be undertaken. The fundamental need for transparent governance of the natural and monetary resources and implementation of the rights and laws can hardly be over-emphasized in the context of flow of funds, especially from external sources. Specific policies for promotion of public and private sectors' investment, loans, credit and subsidy ('smart' subsidy) with special consideration of need and prospect of small farmers, and the provision of necessary institutional and infrastructural support need to be put in place simultaneously. In their negotiations under the WTO Agreement, developing countries must structure the 'green box' or if necessary introduce a 'food security box' in the Agreement, to protect the interest of small farmers and resource-poor .

National vision on investment in land and water: Recognizing the fundamental role of land and water in the very livelihood of people and the state of these resources in the context of sustainable food and environmental security, the Consultation advocated that each nation must develop and adopt a vision on investment in land and water. Each country already has a national water vision. Investment is a mean to achieve a vision. This should be based on the present and future needs of food and agricultural production and productivity and the national and global opportunities. Each nation must assess the extent of cultivated land and irrigation it should have to meet its goals. The extent, status and potential of the resources must be mapped systematically and scientifically, matched with popular aspirations, national capacity and development objectives. One cannot match resources with objectives, This is magic. Instead, one should do the contrary. Based on this, will emerge explicit targets and policies and sectoral and subsectoral priorities for investment in land and water resources.

Bangkok Declaration

The Asia-Pacific Regional Consultation on Investment in Land and Water comprising experts from 12 Asian countries:

Concerned for declining quality and per capita availability of agricultural land and water, for high and increasing human-population pressure – with two-thirds of the world's poor and hungry concentrated in the Asia-Pacific Region, and alarmed by slow progress in achieving the 1996 World Food Summit target of halving by the year 2015 the global total of undernourished adults and children;

Conscious that for land and water – the core, but finite, base for agriculture – conservation, improvement, and judicious use and management are fundamental to sustainable livelihood systems, and that the productivity, profitability, income and employment opportunities and sustainability of Asia's diverse farming systems must be enhanced to ensure long-tem food security for each household in every country;

Recognizing the predominance of small and marginal farm holdings and the risks of degradation of land and water resources through soil erosion, soil-fertility depletion, salt intrusion, waterlogging, flooding, water-table lowering, and water-quality deterioration, and emphasizing the importance of ecotechnology and skilled management for preventing and controlling such degradation processes;

Noting the serious decline since 1990 in national budgets and in donor funding to agriculture in general and to land and water sectors in particular, and mindful of much inefficient and non-transparent governance and of inadequate rights and laws for resource entitlement and utilization;

Stresses the importance and timely opportunity for the **World Food Summit:** ***five years later*** *(*WFS*: fyl)* to re-energize political commitments and investments to arrest and reverse the declines in natural resources and their funding supports, and to accelerate thereby an agriculture-led alleviation of rural and urban hunger and poverty;

Appeals to the Asia-Pacific Heads of State – and to Ministers of Agriculture, Rural Development, Planning and Finance – to galvanize the political will and investment commitment to form policies and take initiatives (in due proportion to the extreme urgency of sustainable natural-resource management) so as to create an enabling environment for advances in agriculture and rural development; and

Calls upon the Heads and Ministers to forge and enable public and private sector cooperation in investment and in peoples' participation for: planning and implementation of watershed and river-basin development, for integrated land, water, and irrigation management, for infrastructural and institutional strengthening and market reforms, for human-resource development – particularly for the generation, adaptation and transfer of pertinent technologies, and for an equity- and gender-sensitive approach to intensifying and diversifying national and regional agricultural economies – thereby inaugurating a sustainable Asia-Pacific Ever-Green Revolution.

Bangkok, 5 October 2001

RESOURCE PAPERS

Investing in Land and Water: The fight against hunger and poverty in the developing Asia

Sustained agricultural growth has been the engine of broad-based economic development, food security and poverty alleviation in most developing countries. Together with labour, capital and technology, land and water constitute the aggregate resource base for agricultural production. Judicious and efficient use of these resources underpins sustained and enhanced agricultural productivity and food security. This calls for increased investment in agriculture, and especially in land and water development.

Unfortunately, contrary to the desired course, investment in land and water and agriculture as a whole is decreasing. The reasons behind the apparent contradiction from a perspective of land and water should be examined in individual countries and ways and means should be sought not only to arrest the decline in investment in land and water, but also to rationally increase the investment in order to achieve desired sustained productivity growth. All stakeholders – governments, private sector, financing institutions, NGOs, farmers, civil societies and international organizations – must take necessary steps to meet the challenges.

This paper (i) gives a brief account of the present situation and prospects of food security, production and poverty, (ii) examines the status of investments in land and water, (iii) analyzes the trend, future needs and mechanisms of investments in land and water, and finally (iv) provides a policy framework for investment in land and water towards sustained food security and prosperity.

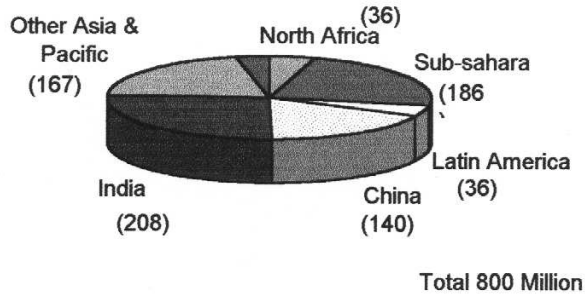
THE FOOD AND AGRICULTURE SITUATION IN THE ASIA AND PACIFIC REGION

Over the past 50 years, the Asia-Pacific Region has undergone an unprecedented transformation in food and agricultural production, food security and rural development. The Green Revolution process, a science-led synergism among enhanced genetic potential (improved seeds), irrigation and fertilizers triggered in the mid-1960s, was the engine of this transformation. During the past 30 years, between 1969 and 1999, Asian cereal production more than doubled to reach nearly one billion tonnes. Despite the addition of 1.3 billion people to the region's population, average per capita food availability increased from about 2 000 kcal/person/day in 1965/1966 to over 2 600 kcal/person/day in 1999/2000. Increased agricultural productivity, rapid industrial growth in many countries and expansion of the non-formal rural economy had almost tripled the per capita GDP. During the last 30 years, the poverty level had fallen from about 60 percent to less than 30 percent.

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Yet, over 500 million Asians are chronically undernourished, accounting for about two-thirds of the world's hungry people (Figure 1). Child malnutrition exacts its highest debilitating toll in Asia and the Pacific region, especially South Asia. Likewise, nearly 800 million persons, two-thirds of the world's poor, have their homes here. It is disquieting that in the recent years the number of hungry and poor people has not been decreasing but remains stubbornly high. Production growths are low and stagnating; moreover, increased agricultural production in the region has often been associated with environmental degradation such as erosion of topsoil, salinization, depletion of soil fertility, lowering of he water table and a fast decline in water availability, waterlogging, pollution of water bodies, eutrophication, build-up of greenhouse gases, ecosystem acidification and loss of biodiversity. Given that the per capita availability of land Asia and the Pacific region is one-sixth of that in the rest of the world, and that nearly three-fifths of the future increase in world population will occur here, future increases in food and agricultural production must be realized from ever-shrinking and generally deteriorating land, water and other production resources. This is indeed an uphill task.

FIGURE 1
Number of undernourished, by region
Source: FAO, CFS: 2001/2



There is a strong link between poverty and food insecurity. As seen in Table 1, from 1987 to 1998, as the incidence of poverty fell in Asia, the Middle East and North Africa, levels of undernourishment declined as well. South Asia, which in 1998 had 522 million people with incomes less than US$1/day, registered 44 percent of the world's poor as well as the largest number of undernourished people, some 294 million, or over 39 percent of the world's hungry. Therefore, the twin objectives of the World Food Summit (WFS) and the UN Millennium Summit of reducing undernourishment and poverty by half by the year 2015 are highly interconnected and interdependent.

DEMAND AND SUPPLY OUTLOOK TO 2015/2030

Food demand in developing countries is essentially a function of population growth and income increase. As world population registered 4.44 billion people in 1995/1997, developing countries accounted for 77 percent of the total (Table 2). In 2030, this proportion will rise to 83 percent, with an estimated world population of 6.7 billion. South and Southeast Asia together will continue to account for over 50 percent of the world's population – 53 and 52 percent towards 2015 and 2030, respectively – although rates of growth will decelerate considerably, especially in East Asia. Given the high base level population and not-so-low growth rates, the share of South Asia in the world's population will increase from the current level of 22 percent to 24 percent in 2030, annually adding 19 million persons towards 2015 and 16 million towards 2030. The corresponding increments for East Asia are 16 and 9 million respectively. In the next 30 years, nearly one billion additional people will be added to the populations of South, Southeast and East Asia, and half of this addition will take place in India and China.

TABLE 1
A comparison of poverty and undernourishment data

Region	1998	1996-1998	1996-1998	1998
	People in households consuming less than $1/day (%)	Share undernourished (%)	Number of undernourished (million)	Number of poor (million)
East Asia	15.32	12	155.0	278.32
Eastern Europe/Central Asia	5.14	6	26.4	23.98
Latin America/Caribbean	15.57	11	54.9	78.16
Middle East/North Africa	1.95	10	35.9	5.55
South Asia	39.99	23	294.2	522.00
Sub-Saharan Africa	46.3	34	185.9	290.87

Source: FAO, CFS, 2001/2002

Projected per capita income growth (GDP) in Asian subregions between 1995/1997 and 2015 and between 2015 and 2030 range from 3.6 to 5.7 percent and are generally higher than the corresponding growth for developing countries as a whole (Table 3). This growth will greatly help in reducing the poverty level in the region and maintain a fairly high demand for food and agricultural products, leading to reduced undernourishment.

TABLE 2
Population data and projections

	1995/1997		2015		2030		Growth rate %	
	Million	% world	Million	% world	million	% world	1995/ 1997-2015	2015-2030
World	5 745	100	7 154	100	8 112	100	1.2	0.8
Developing countries	4 436	77	5 778	81	6 718	83	1.4	1.0
South Asia	1 251	22	1 651	23	1 915	24	1.5	1.0
Southeast Asia	1 800	31	2 133	30	2 307	28	0.9	0.5

Source: Agriculture: Towards 2015/2030, FAO

Table 4 gives balances of cereals production and demand over 1995/1997-2015/2030 as analyzed by FAO (2000). By the year 2030, the world cereal production would need to be increased to 2.8 billion tonnes, an addition of nearly one billion tonnes. In South, Southeast and East Asia, cereal production is expected to increase by 380 million tonnes, from 720 million tonnes in 1995/1997 to 1 100 million tonnes in 2030. Comparing the subregions, South Asia is expected to register an increase of 73 percent, whereas East Asia (including South East Asia) is expected to register an increase of 44 percent. Cereals demand is expected to outstrip production both in South and East Asia, the self-sufficiency rate in South Asia falling from 97 to 94 percent and in East Asia from 94 to 90 percent over 1995/1997-2030.

TABLE 3
GDP growth rate, percent per annum

Region	Total GDP		Per capita GDP	
	1995/1997-2015	2015-2030	1995/1997-2015	2015-2030
World	3.1	3.6	2.0	2.7
Developing Countries	4.8	5.4	3.4	4.3
South Asia	5.1	5.1	3.6	4.0
East Asia	5.8	6.3	4.9	5.7

Source: Agriculture; Towards 2015/2030, FAO

TABLE 4
Cereal balances, demand and production (million tonnes)

YEARS	DEMAND		PRODUCTION	SSR*%
	FOOD	ALL USES		
WORLD				
1995/1997	**979**	**1 844**	**1 836**	**100**
2015	**1 257**	**2 393**	**2 397**	**100**
2030	**1 428**	**2 801**	**2 805**	**100**
DEVELOPING COUNTRIES				
1995/1997	**765**	**1 107**	**996**	**90**
2015	**1 029**	**1 550**	**1 352**	**87**
2030	**1 197**	**1 886**	**1 615**	**86**
SOUTH ASIA				
1995/1997	**211**	**235**	**227**	**97**
2015	**306**	**343**	**327**	**95**
2030	**368**	**418**	**392**	**94**
EAST ASIA				
1995/1997	**348**	**526**	**493**	**94**
2015	**413**	**683**	**624**	**91**
2030	**432**	**787**	**708**	**90**

Source: Agriculture: Towards 2015/2030, FAO
*SSR = Self Sufficiency Rate = Production/Demand (all uses)

A livestock revolution is underway in the developing countries, particularly in Asia, with profound implications for crop-livestock balance, nutrition, income and the environment. Asia registered the highest growth rate in the world in livestock production in past decades and is projected

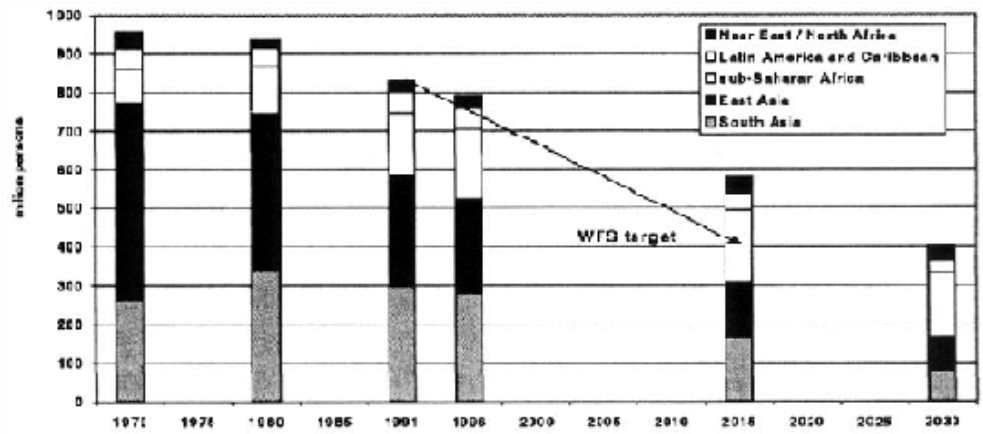
to maintain this trend towards the year 2030 (Table 5). South Asia, in particular, will register much higher growth rates – 3.2 percent against 1.7 percent for the world as a whole. East Asia will also maintain high growth rates, particularly from 1997 to 2015. East Asia (40.4 percent) and South Asia (10.4 percent) together will account for more than half (about 51 percent) of increased global meat production. Further, there will be an expansion of the industrial production of livestock. These trends will put added pressure on water for consumption and environmental health.

TABLE 5
Annual growth rate (%) of total livestock production

Region	1987-1997	1995/1997-2015	2015-2030
World	**1.8**	**1.7**	**1.4**
South Asia	**4.3**	**3.2**	**3.2**
East Asia	**8.9**	**2.6**	**1.6**

Source: Agriculture: Towards 2015/2030, FAO

FIGURE 2
Incidence of undernourished (million persons)



Source: FAO, SOFI, 2000

Varied demand and supply projections of cereals, livestock and other food products indicate a significant increase in per capita food consumption, particularly in developing countries, to 2 860 and 3 020 kcal in 2015 and 2030 respectively. In South Asia the corresponding figures are 2 790 and 3 040 kcal and in East Asia the projections are still higher, 3 020 and 3 170 kcal. These increases will lead to a further significant drop in the share of persons undernourished to 10 percent in 2015 and 6 percent in 2030 for the developing countries, to 10 percent and 4 percent for South Asia and to 7 percent and 4 percent for East Asia (Table 6). However, due to continued demographic growth (in absolute numbers), the decrease in the number of undernourished persons will only be to 576 million in 2015 and 401 million in 2030 from 790 in 1995/97 for Asia to 309 in 2015 and 168 million in 2030 from 524 in 1995/97. As of late 2001, the World Food Summit (WFS) goal of halving the number of undernourished persons no later that 2015, would only be reached towards 2030 (Figure 2).

TABLE 6

Incidence of undernourishment in developing countries

Region	Million Persons			Percent of Population		
	1995/1997	2015	2030	1995/1997	2015	2030
Developing Countries	790	576	401	18	10	6
South Asia	284	165	82	23	10	4
East Asia	240	144	86	13	7	4

Source: Agriculture: Towards 2015/2030, FAO

SOURCES OF CROP PRODUCTION GROWTH

From 1967 to 1997, the developing countries registered a satisfactory crop production growth rate of 3.1 percent (Table 7). East Asia, with a growth rate of 3.6 percent, played the leading role in increasing the global average. South Asia, with a growth rate of 2.8 percent, also performed well. During the succeeding 34-year period, the growth rate is expected to slow to 1.2 percent in East Asia but maintain a moderate level of 1.9 percent in South Asia. Yield gains during the Green Revolution era were generally attributed to almost equal contributions of genetically improved seeds, irrigation and fertilizer with highly significant interactions.

TABLE 7
Annual crop production growth rate (percent per annum)

Region	1967-1997	1995/1997-2030
South Asia	**2.8**	**1.9**
East Asia	**3.6**	**1.2**
All Developing Countries	**3.1**	**1.6**
Industrial Countries	**1.4**	**0.8**
World	**2.2**	**1.3**

Source: AgricultureTowards 2015/2030, FAO

There are three sources of growth in crop production: (i) arable land expansion, (ii) increased cropping intensity and (iii) yield growth. Yield growth accounts for 83 percent of production growth in Asia, whereas expansion of the net area under cultivation contributes only 5 percent. The remaining 12 percent will be through increased cropping intensity (Table 8). In other words, 95 percent of the crop production growth in Asia will accrue through crop intensification and only 5 percent through net area expansion, while in other regions net area expansion will contribute from 20 to 30 percent.

Increased production of wheat and rice in developing countries will need to come from gains in yield (about four-fifths), whereas maize will rely equally on expanded area planted, even more than in the past. In Asia, wheat and rice will have negligible or zero net area growth (or even negative growth in some major producing countries). Thus yield growth will be the exclusive source of increased production.

TABLE 8
Sources of growth in crop production (percent)

Region	Arable land expansion		Increase in cropping intensity		Yield increases	
	1961-1997	1995/1997 -2030	1961-1997	1995/1997 - 2030	1961-1997	1995/1997 - 2030
South Asia	7	5	14	12	79	83
East Asia	26	5	-6	12	80	83
All developing countries	24	20	5	11	71	69

Source: Agriculture Towards 2015/2030, FAO

AGRICULTURAL LAND

The developing countries will expand their total arable land area by 120 million ha between 1995/1997 and 2030 (Table 9). This includes an increase of only 15 million ha in Asia (9 million ha in South Asia and 6 million ha in East Asia, with annual growth rates of 0.13 and 0.07 percent respectively). India and China together account for about 28 percent of the developing countries' arable land. India's share of arable land in South Asia was overwhelming, some 82 percent. In South Asia, nearly 90 percent of arable land is already under use, whereas in East Asia, more than 40 percent of the available potential is unused. In South Asia excluding India, about 15 million ha of land unsuited for agriculture has been brought under plough, raising sustainability concerns. By 2030, while in the developing countries about 1.7 billion ha additional potentially arable land will be available, in Asia only 132 million ha will be potentially available for area expansion (4 million ha in South Asia and 128 million ha in East Asia), again emphasizing the importance of yield growth in Asia.

In Asia, future expansion in cropped area will accrue essentially as expansion of gross cropped areas through increased cropping intensity. The overall cropping intensity for developing countries will rise by 8 percent from 1995/97 to 2030, from 91 to 98 percent (Table 10). Of necessity, and also as one-third of the cultivable land is irrigated, in South and East Asia (particularly China) cropping intensity was the highest, 126 percent in South Asia and 158 percent in East Asia under irrigated conditions. In rainfed also it was over 100 percent. Towards 2030, there will be further intensification of 11 percent both in South and East Asia. In certain agro-ecological settings, covering vast irrigated areas in South and Southeast Asia, cropping intensity is 200 percent or more. It may be emphasized that increased cropping intensities are associated with increased risk of land and environmental degradation when it is not accompanied by appropriate technologies and policies. Investment decisions and management must therefore also internalize environmental costs and other externalities.

IRRIGATION AND WATER USE

As seen from Table 11, the irrigated area in the developing countries will increase by 54 million ha (or 23 percent) between 1995/97 and 2030. This means that 22 percent of potentially irrigable land will be brought under irrigation, and 60 percent of all land with irrigation potential (402 million ha) will be in use by 2030. About 75 percent of the developing countries' irrigated area in 1995/97 was in Asia. This share is projected to be retained through 2030. In other words, nearly 75 percent of projected increase in irrigated area in the developing countries would materialize in Asia. Further, China and India together will continue to possess about 54 percent of the developing countries' total irrigated area, with India accounting for 28 to 29 percent. South Asian irrigation figures are heavily impacted by India as it accounts for 71 and 74 percent of the subregion's total irrigated area in

1995/1997 and 2030, respectively. Of the projected increase of 17 million ha under irrigation in South Asia, 15 million ha will be in India.

TABLE 9
Total arable land: data and projections

Region	Arable land in use (million ha)			Annual growth (%)		Land in use as percent of potential		Balance (million ha)	
	1995/ 1997	2015	2030	1961-1997	1995/1997 - 2030	1995/ 1997	2030	1995/ 1997	2030
South Asia	207	212	216	0.18	0.13	84	88	13	4
Excluding India	37	38	39	0.37	0.15	90	95	-14	-16
East Asia	232	236	238	0.91	0.07	57	58	134	128
Excluding China	98	108	113	0.89	0.41	47	53	89	74
Developing Countries	960	1033	1079	0.68	0.34	32	36	1822	1703
Excluding China/India	656	731	777	0.81	0.50	25	30	1751	1630

Source: Agriculture Towards 2015/2030, FAO

TABLE 10
Cropping intensity (percent)

Region	Rainfed use		Irrigated use		Total land in use	
	1995/97	2030	1995/97	2030	1995/97	2030
South Asia	102	109	126	137	111	122
East Asia	118	120	158	169	130	137
Developing countries	82	85	129	140	91	98
Excluding China/India	68	75	105	118	73	81

Source: Agriculture Towards 2015/2030, FAO

The expansion of irrigation during the Green Revolution era in the developing countries registered a growth of 94 million ha (1.9 percent per annum), but as the demand rate decelerates during the next 34 years the growth rate is projected to drop to 0.6 percent, due to both the increasing cost of bringing additional area under irrigation and retreating water resources. However, because of increased cropping intensity in areas under irrigation, irrigated areas in the next 34 years will increase by 86 million ha. Most of this gain will occur in Asia, where total irrigated area will reach about 40 percent, against 14 percent in the developing countries excluding China and India (Table 12). In South Asia (excluding India), where there is very high pressure for crop intensification, irrigation intensity is already extremely high (62 to 64 percent), particularly due to Pakistan where irrigation intensity can reach 80 percent. Therefore, the performance of irrigated agriculture in India, China and Pakistan will greatly impact the developing world's irrigated agriculture production.

TABLE 11

Irrigated (arable land): data and projections

Region	Irrigated land in use (million ha)			Annual growth (%)		Irrigated land as percent of potential		Balance (million ha)	
	1995/ 1997	2015	2030	1961-1997	1995/ 1997 - 2030	1995/ 1997	2030	1995/ 1997	2030
South Asia	78	85	95	2.2	0.6	55	67	64	47
Excluding India	23	24	25	1.9	0.2	82	89	5	3
East Asia	69	78	85	1.5	0.6	62	76	43	27
Excluding China	18	22	25	2.0	0.8	40	52	29	23
Developing Countries	197	220	242	1.9	0.6	49	60	206	160
Excluding China, India	91	103	112	2.0	0.6	40	50	134	113

Source: Agriculture Towards 2015/2030, FAO

TABLE 12
Irrigated land as percent of total arable land

Region	1995/97	2015	2030
South Asia	38	40	44
Excluding India	62	63	64
East Asia	30	33	36
Excluding China	18	20	20
Developing Countries	21	21	23
Excluding China/India	14	14	14

Source: Adapted from Agriculture Towards 2015/2030, FAO

Agriculture accounts for about 70 percent of the freshwater use in the world. Increasing withdrawal of freshwater for agriculture is one of the main causes of water scarcity which several countries are facing today and many more will face in the future, and more acutely. Therefore, irrigation water must be used most efficiently. As seen in Table 13, irrigation efficiency in the developing countries averaged about 43 percent in 1995/97, varying from 26 percent in Latin America (having abundant water resources) to 50 percent in the Near East/North Africa region and 49 percent in South Asia (water-scarce regions). Improved irrigation technologies, modernization and rehabilitation of irrigation and appropriate water resources policies, means that each region should improve its irrigation efficiency, with maximum improvement taking place in the Near East and North African region (15 percent), followed by South Asia (9 percent). In East Asia, less China, efficiency is rather low and must be improved considerably. This may be partially attributable to the predominance of rice cultivation in Southeast Asia where paddy fields are flooded to facilitate land preparation and weed management.

TABLE 13
Irrigation efficiency (percent) in developing countries

Year	Sub-Saharan Africa	Latin America	Near East-North Africa	South Asia	East Asia	All developing countries
1995/97	**42**	**26**	**50**	**49**	**38**	**43**
2030	**44**	**29**	**65**	**58**	**42**	**50**

Source: Agriculture Towards 2015/2030, FAO

The role of irrigation in enhancing yield and total production (including increased cropping intensity) is also evident. In 1995/97 the developing countries averaged 1.71 tonnes/ha yield for rainfed cereals, projected to grow to 2.23 tonnes/ha in 2030, as compared to 3.82 and 5.16 tonnes/ha for irrigated conditions (Table 14).

TABLE 14
Cereal yields in developing countries, rainfed and irrigated

Water regime	Share in area (percent)		Share in production (percent)		Average (weighted) yield (tonnes/ha)			Annual yield growth (percent per annum)		
	1995/1997	2030	1995/1997	2030	1961/1963	1995/1997	2030	1961-1997	1987-1997	1995/1997-2030
Rainfed	62	57	42	37	-	1.71	2.23	-	-	0.8
Irrigated	38	43	58	63	-	3.82	5.16	-	-	0.9
Total	-	-	-	-	1.17	2.52	3.49	2.5	1.9	1.0

Source: Agriculture Towards 2015/2030, FAO

WHY THE EMPHASIS ON INVESTMENT IN LAND AND WATER

Land and water are not only the basis of agriculture but of life itself. Protecting, developing and maintaining the health and viability of these basic resources is fundamental to the survival and progress of humanity. Investment in land and water must be viewed as investment in sustained food security, income, prosperity, environment and health. 'Crop per drop' as advocated the International Water Management Institute, emphasizes the importance of conservation and judicious use of scarce resources.

The World Bank (2001) estimates that by 2025 as many as 48 countries and some 1 400 million people – mostly in least developed countries – will experience water stress or scarcity. Besides lowered water availability (quantity), deteriorating water quality and environmental conditions, irrigation-related land degradation and insufficient river flow will aggravate water shortage problems, which could depress agricultural production and limit industrial and household use (IFAD, 2001).

Worldwide, according to Global Land Assessment of Degradation (GLAD) mapping of nearly 105 billion ha of cropland, 38 percent is degraded (Table 15). Africa has the most extensive cropland degradation (65 percent), followed by Latin America (51 percent) and Asia (38 percent). Water

erosion and wind erosion, in that order, were the main causes of degradation. In monetary terms, global losses due to land degradation in drylands ranges from US$13 billion to US$28 billion per year.

TABLE 15
Agricultural land degradation in different regions (million ha)

Region	Total	Non-degraded	Degraded
Latin America	180	88	92
Asia	536	330	206
Africa	187	66	121

Source: Oldeman, 1992

The average cumulative loss of cropland productivity at the world level during the post-Second World War period as a result of human-induced soil degradation was 12.7 percent, and at the Asia level it was 12.8 percent (Oldeman, 1998). Land and water resources have degraded almost to the point of no return in certain agro-ecological pockets in some countries, primarily due to wrong technologies, poor management and greed. These trends must be understood as warnings that livelihood systems are the basis of society and civilization itself is threatened.

In Asia and the Pacific region there is limited scope of horizontal expansion of cultivated land and irrigated area; per capita availability of agricultural land and water has been decreasing due to population growth and the diversification of agricultural land to non-agricultural uses. Moreover, large proportions of the resources have degraded and numbers of large irrigation structures have aged and degenerated. For instance, in South Asia 73 percent of agricultural land suffers from forms of degradation (Table 16). All forms of land degradation in South Asia are estimated to cost US$9.8 to 11 billion per year (FAO/UNDP/UNEP 1994), or 7 percent of agricultural GDP. Therefore, increasing emphasis will need to be placed on rehabilitation and improving degraded resources.

The total land area of Asia and the Pacific region is 3 001 million ha or 22.9 percent of world land area. Possible agricultural production in 86 percent of the region is limited by adverse soil, climatic and topographic factors, including cold (2 percent), dryness and aridity (19.4 percent), steep slopes (26.7 percent) and chemical problems (13.5 percent). Thus, only 14 percent of the region's total land area is free from constraints on agricultural production.

Soil degradation – in particular loss of potential soil productivity due to erosion and soil nutrient decline – is the biggest threat to meet the future agricultural needs in the region. Adequate investment needs must be mobilized for enabling community owned watershed development programmes and for optimal fertilization programmes to offset the continuing negative balance of nutrient status of the soil. The loss of soil productivity in both the commercial and subsistence sectors has national costs and effects, such as the need for more food imports, lessened exports, the possible necessity of relief supplies and the need for added agricultural investment. Less tangible but necessarily added to this are the social welfare costs associated with assisting those who fall below the poverty line.

Over-extraction of ground water is widespread and is caused by industrial, domestic and agricultural withdrawals. In substantial areas of China and India, groundwater levels are falling by 1 to 3 metres per year. Over-extraction in coastal areas causes saltwater to intrude into freshwater aquifers. Investment in groundwater utilization must be based on waterbalance and the recharge data of the area and the spatial distribution of wells and pumps must also be regulated accordingly.

TABLE 16
Shares of agricultural land in South Asia affected by different forms of degradation

Type of land degradation	Percent of land affected
Water erosion	25
Wind erosion	18
Soil fertility decline	13
Waterlogging	2
Salinization	9
Lowering of water table	6

Source: FAO/UNDP/UNEP, 1994

Commonly encountered environmental degradations such as waterlogging, salinization, overextraction, the use of fossil aquifers, pollution of surface and ground water and their associated economic and social costs can be minimized through appropriate and timely management interventions. Land and water investment decisions also have serious implications for global warming and climate change. The potential for carbon sequestration in soil may be as high as 40 percent of total annual atmospheric increases in CO_2 concentration. Water management practices can greatly impact methane emission from paddy fields – an important point of consideration for Asia and the Pacific as about 90 percent of the world's paddies fall in this region.

Relative impact of soil degradation will vary under different agricultural settings. In Asia, for example, it is projected that by 2020 economic effects of soil degradation will be most severe in densely populated marginal lands followed by irrigated lands (Table 17). National policy priorities for managing degraded lands will thus vary widely and must be determined by each country's resource endowment, the structure of agricultural supply, distribution of poverty, and the principal agricultural sources of economic growth (Scherr, 1999).

Fresh water is distributed very unevenly across the globe, with the lowest availability in Asia and the highest in South America (Table 18). It is projected that by 2025, 46 to 52 countries with an aggregate population of 3 billion will be water stressed (Engelman and Le Roy, 1993). Fuelled by population and industrial growth, between 1950 and 1990 water use increased by 100 to 500 percent in different regions. Agriculture is the biggest user of water, accounting for more than 90 percent of water withdrawals in low-income developing countries (Table 19). The decreasing per capita availability of water is exacerbated by the increasing cost of developing new water, wasteful use of already developed water supplies, degradation of soil in irrigated areas, depletion of groundwater, water pollution, and distorted water policies and pricing.

INVESTMENT REQUIREMENTS

Investment requirements can be grouped into two interdependent categories: the *monetary requirement* and the *human resources and attitudinal requirement*. Land intensification needs may generally encompass investments for such needs as: i) soil fertility maintenance by adequate levels of balanced fertilization and management of structural, textural and organic health; ii) land shaping for adoption of minimum tillage and other land operation practices; iii) soil conservation and afforestation measures; iv) reclaiming acid, saline and alkali soils, ravine areas; stabilizing sand dunes, waterlogged and other degraded land; and v) enriching the biological health of soils.

TABLE 17
Relative impact of soil degradation in different agricultural pathways

	Anticipated impact of soil degradation on					
In order of global policy priority	Consumption by poor farmers	Agricultural market supply	Economic development	National wealth	Severity of problem	Dependence on direct policy action to resolve
Densely populated marginal lands	↓ ↓ ↓	↓ ↓	↓ ↓ ↓	↓ ↓	↓ ↓ ↓	↓ ↓ ↓
Irrigated lands	↓ ↓	↓ ↓ ↓	↓ ↓ ↓	↓ ↓ ↓	↓ ↓	↓ ↓
High-quality rainfed lands	↓ ↓	↓ ↓ ↓	↓ ↓ ↓	↓ ↓ ↓	↓	↓
Urban and peri-urban agricultural lands	↓	↓	↓	↓	↓	↓ ↓ ↓
Extensively managed marginal lands	↓ ↓	↓	↓	↓	↓	↓

Notes: Resolution of soil degradation problems (last column) requires a strong agricultural economy with farmer incentives and capacity for good land husbandry. Sensible agricultural/rural policies and infrastructure investments are needed. The last column refers to policies and public investments needed to control soil degradation. ↓ ↓ ↓ indicate high, ↓ ↓ medium, and ↓ low.
Source: Scherr, 1999

TABLE 18
Per capita water availability by region, 1950-2000 (km^3 per year)

Region	1950	1960	1970	1980	2000
Africa	20.0	16.5	12.7	9.4	5.1
Asia (excluding Oceania)	9.6	7.9	6.1	5.1	3.3
Europe (excluding Soviet Union/Russia)	5.9	5.4	4.9	4.6	4.1
North America and Central America	37.2	30.0	25.2	21.3	17.5
South America	105.0	80.2	61.7	48.8	28.3

Source: Ayibotele, 1992

Likewise, investment in water resources, supply and use is required for: i) design and construction of large, medium, small and micro irrigation schemes; ii) rehabilitation, upgrading and modernizing existing irrigation schemes and systems; iii) developing new and tapping unutilized water resources; iv) developing river basin-based integrated development and water management; v) preventing water pollution and deterioration of water quality; and vi) integrated watershed development encompassing upgradation of arable land, non-arable land and underground water, particularly in rainfed areas in arid and semi-arid zones.

Long-term investment in land and water must be based on well-conceived national land use and water policies, taking into account intersectoral demands, growth prospects and other national priorities. FAO agro-ecological zoning methodology provides a broad framework for developing an appropriate national land use policy. Land and water development programmes for different zones should be reflect this methodology and make a strong case for including land and water resources as

priority areas for ODA allocations within the framework of food security and poverty reduction strategies. Irrigation and water requirements must be systematically and scientifically assessed in the context of the availability of cultivable land, food and agricultural production goals and demand-supply balance. Governments must be aware and capable of using 'global' and 'local' models to assess and plan for needs and prospects.

TABLE 19
Sectoral water withdrawals by country income group

Country income group	Annual per capita withdrawal (cm^3)	Withdrawals by sector (%)		
		Agriculture	Industry	Domestic use
Low-income countries	386	91	5	4
Middle-income countries	453	69	18	13
High-income countries	1 167	39	47	14

Source: World Bank, 1992

Investment in research, technology development and extension in land and water management is necessary to increase water use and development efficiencies. This is important because existing efficiencies are generally low, varying from country to country (hence the scope for learning from each others' experiences), and secondly, future increases in production must essentially accrue through increases in yield and productivity for every drop of water and every inch of cultivated land. As mentioned earlier, nearly three-fourths (74 percent) of the irrigated land of the developing world is in Asia, 14 percent in the Near East and North Africa, 9 percent in Latin America and 3 percent in Sub-Saharan Africa. Further, irrigated agriculture is projected to account for a 38 percent of increase in arable land and more than 70 percent of the increase in cereal production between 1997 and 2030. Against these projections, it is worrisome to experience stagnating yields, low yields and declining rates of yield growths, let alone the widespread degradation of the land and water resources.

Viewed against this background, the investment scenario for water resource development is disquieting. From 1950 to 1993, only 7 percent of World Bank lending was allocated to agriculture and rural development – discouragingly low in both in terms of percentages and absolute amounts. This does not augur well for the anticipated increase in irrigated land between 1997 and 2030, although it has been shown that in 192 water resource development projects, the internal rate of return on investment was an average 16 percent (Jones, 1995).

The social context of irrigated agriculture is highly relevant. The high population absorptive capacity of irrigation limits the migration of growing populations to areas of greater environmental risk. If additional water for irrigation or additional irrigated areas are not forthcoming, the increased burden on rainfed agriculture to meet demand will be enormous and detrimental to environment, with far more deforestation and land clearance.

Research and development efforts in land and water sectors, backed up by adequate investment, should cover: I) mapping and utility classification of land and water resources; ii) improving the efficiency of land and water use in agriculture; iii) policy, institutional, economic and social aspects of land and water management; iv) management of watersheds for multiple functions; v) management of aquatic ecosystems, in particular those having boundaries with terrestrial

ecosystem; vi) wastewater recycling, and the conjunctive use of water, improvement of water quality and reduction of water pollution; vii) restoration of fertility and structure of degraded lands and prevention of further degradation, bioremediation; and viii) integrated soil-water-plant-nutrient management and fertility improvement.

Water accounting methods developed by the International Water Management Institute (IWMI) can help planners improve water productivity by analyzing where it is going, who is using it, how productive it is per cubic metre and whether it is available for reuse. Likewise, soil fertility and health indicators are increasingly available and should be used for assessing resources and investment priorities.

TREND OF INVESTMENT

Investments in agriculture, including land and water and research and technology developments have been declining. This is paradoxical to the projected demands for food and agricultural products and supply constraints. It is a matter of great concern that most developing countries in recent years assign only 6-8 percent of their spending to the agriculture sector, although 60 percent of their populations depend on agriculture – and poverty continues to be essentially a rural phenomenon.

More than 90 percent of investment in agriculture in most developing Asian countries comes from domestic resources, although in some low-income food deficit countries the proportion of dependence on foreign assistance may be as high as 25-30 percent. In irrigation, about 90 percent of the estimated investment of US$60-80 billion annually in developing countries is based on domestic sources (DFID, 2000, World Bank, 2001). Current levels of investment in water are only 50 percent of the minimum needed. World Bank lending to irrigation was 7 percent of its total lending in 1950-1993, more than any other sector (Jones, 1995), but had dropped to 4 percent during 1990-1997 (DFID, 2000). Shrunken and shrinking investment in the water sector is bound to be a major bottleneck in meeting the projected food and agricultural production in developing countries.

The official flow of funds to agriculture has declined to 63 percent of that at the beginning of the decade. At 0.24 percent of annual GDP, current levels of foreign aid fall short of the 0.7 percent target set by developed countries. Actual aid falls short of that target by US$100 billion a year. In the late 1990s, aid and lending to agriculture was one-third the level of the late-1980s which itself was down from the late-1970s level. The share of agricultural lending in the loan portfolio of the World Bank fell below 10 percent in 2000 compared to an average of 14 percent for the decade ending 2000. Thirty years ago the figure was 40 percent (FAO, 2001).

It is well known that countries with high levels of undernourishment also have severe budgetary constraints. Countries with one-quarter of their population as undernourished spend at least 30 times less per agricultural worker as compared with countries having less than 5 percent of population as undernourished (FAO, 2001). Hence the case for a larger flow of concessional development assistance to Low Income Food Deficit Countries (LIFDCs) to effectively face the challenge of food insecurity and undernutrition cannot be overemphasized.

Besides serious gaps in the financial flow to agriculture, particularly to land and water, there are serious gaps in management and priorities. Moreover, there are serious conflicts between quick gains and long-term sustainability. Several successful experiences of land and water management with tremendous impacts on production, productivity, food security, poverty alleviation, income, trade, and sustainability exist in Asia and elsewhere which must be critically documented and shared with other countries. Cases of failure should be critically analyzed and the causes should be studied by all to avoid further failures.

Local wisdom and indigenous knowledge and technologies have many times been effective in land and water management, but in the rush for quick fixes and due to a lack of vision and perspective, such sources of indigenous understanding are dying. Managers of investment in land and water must recognize traditional knowledge and experience, and blend them with modern technologies referred to as ecotechnology. The need for investing in the people themselves, in shaping their attitudes and participation, can hardly be overemphasized. The people are true guardians, service providers as well as beneficiaries, and hence development must be rooted in a spirit of participation – "of the people, by the people and for the people".

Uncertainty of land tenure is a significant deterrent to long-term and sustainable investment on land. Ambiguities relating to rights of land, water and trees tend to contribute to environmental degradation and curb investment desires. Other institutional aspects include the absence of clear community mechanisms for upkeep of public assets and infrastructure, lack of financial services and the marginalization of women. The absence of micro-credit institutions discourage investment in soil and water conservation measures, particularly if payback periods are relatively long.

FINANCING MECHANISMS

The decrease in the proportion of public investment and donor loans and grants invested in the agricultural sector has come about because of a greater priority given by governments to investments to develop other sectors (such as infrastructure, energy, transport, education and health). Within the agricultural sector in Asia, however, there is a shift by governments to invest proportionately more in natural resources management (soil, plant and water resources), forestry, fisheries and integrated rural development. Priority is also being given to rehabilitation of existing irrigation schemes rather than the development of new large schemes and donors are very reluctant to invest in dams.

Governments and international donors have generally avoided investments in reforming the rural financial system and developing credit facilities to small farmers with little or no collateral. Private investment in land had been mostly limited to large estate and orchard crops. Government services to farmers are being reshaped by decentralization of government services, with some reduction in quality of services. Governments are also involved in privatizing many services. These trends, along with the WTO settings, are creating changed circumstances in which small farmers have to produce agricultural products and generate family incomes. The impact of these changes on farmers and rural communities and future priorities for investment in the rural and agricultural sector should be analyzed. Besides identifying the priority areas for investment, it would be essential to analyze the various financing mechanisms and their linkages. These linkages must be managed in consistence with the appropriate rights and laws related to the resources and their transparent governance.

A flexible, responsive and multi-directional financing mechanism is needed. Country-owned poverty reduction strategies (CPRS) can be articulated to provide the basis for donor concessional assistance (particularly World Bank and IMF lending) and the use of resources freed by debt relief enhanced under the highly indebted poor countries (HIPC) initiative. The World Bank's Comprehensive Development Framework (CDF) or its equivalent, the UN Development Assistance Framework (UNDAF) at the country level, may form a basis for coordination of programmes and action plans based on each country's Poverty Reduction Strategy Paper (PRSP). Of the 23 LIFDCs with the highest prevalence of undernourishment, 17 are in the HIPC group of eligible countries. Overall, 41 countries with US$170 billion in external debt are eligible for consideration under the HIPC initiative. The enhanced initiative seeks to establish stronger link between debt relief and sustainable poverty reduction programmes in recipient countries.

A flexible lending framework is suggested as a mechanism for implementing CPRS. In this mechanism, World Bank may take the lead in providing broad-based poverty reduction support credit (PRSC) linked to key objectives, reform areas and priority action areas such as land and water development. Governments will receive the credit on IDA terms geared to performance. The funding is integrated with the government budgetary cycle and augments the capacity to allocate resources on a cross-sectoral basis. In this process and facilitation, FAO has a role in assisting governments in articulating agriculture sector strategy and in the formulation of programmes within CPRS framework. This also provides scope for interested bilateral donors to enter into partnership with FAO to support such programmes.

Private sector participation in investment and management must be encouraged. Market distortions, imperfect access to information and uncertainty about cost-benefit relationships pose discouragement to private sector participation. However, this area requires capacity building in entrepreneurial skills and facilities for financial services and working capital support. Decentralized financing mechanisms are needed to facilitate such provisions as extension, micro-credit and information sharing.

INVESTMENT POLICIES AND STRATEGIES IN LAND AND WATER DEVELOPMENT

Agriculture will continue to be the engine of broad-based economic growth and development in most Asian countries. The unprecedented success in increasing production, productivity, income growth, food security and poverty alleviation through the Green Revolution process underpins the synergistic interplay of soil fertility, irrigation, improved seeds, management practices, labour, capital, technology and political will. In recent years, however, it is seen that the pace of growth of yield and productivity has decelerated, and is even stagnating under major production, regimes such as the rice-wheat system, let alone rainfed areas. Keeping in mind the projected demands of food and agriculture, the state of land and water and the overall environmental health, it will be essential to effect several paradigm shifts to transform the Green Revolution into Evergreen Revolution to achieve sustained agricultural growth.

Given that there is negligible scope for horizontal expansion of agricultural land in Asia and the Pacific region, the only option left is the intensification and diversification of the production system for sustainably enhancing yield and productivity. Considering the assets and liabilities of the Green Revolution process, the approach towards Evergreen Revolution must be structured on a system-based, interdisciplinary and participatory approach. It must promote efficiency and inclusiveness and seek congruence of productivity, sustainability, profitability and equity. Based on this premise, the following policy framework is suggested for investment (financial and management) in land and water.

Integrated approach to land and water management and investment strategy

Although they are two distinct and most fundamental natural resources – not only for agriculture but for the very life and existence of humankind – land and water are intimately interrelated resources. The extent, quality and productivity of the two resources are highly interdependent. Therefore, while there must be land-specific and water-specific conservation, development and utilization policies, strategies and programmes, there is a need to have clear policy and approach for synergistic development and effective integration of land and water to enhance overall productivity, sustainability, profitability and reduction of environmental costs.

Agricultural area expansion in the land-hungry Asia-Pacific region is largely dependent on gross cropped area expansion (increased cropping intensity), which is closely linked with irrigation

intensity. It is often noticed that expanding irrigation without drainage facilities and efficient on-farm water management has resulted in vast land degradation in the form of waterlogging and salinity, thus negating the gain. This highly costly and negative trend can and must be discouraged; it can be reversed only by integrating the development of the two resources. Clearly, an interdisciplinary approach is essential. It must involve land and soil specialists, water and irrigation experts, agronomists, engineers, designers, economists, sociologists and even anthropologists. Above all, the people themselves, working as partners in a participatory mode, is required. An integrated approach of policies and investment is essential to promote land and water protection, rehabilitation, development and quality improvement leading to sustainable agricultural supply, economic growth, rural welfare and long-term national wealth.

A system-based integrated approach is needed also within each subsector. Supply and demand management strategies and policies constitute a continuum. Supply management strategies encompass location, development and exploitation of new sources of agricultural land and water. Demand management strategies encompass incentives and mechanisms which promote conservation, improvement and efficient use of the resources. The importance of the constituent parts of the two strategies varies depending on the resource availability and level of overall and agricultural development. In the Asia-Pacific region, per capita scarcity of land and water resources on one hand – and pressure for intensification and diversification of resources and their economies and environmental costs on the other – call for greater attention to demand management strategies. The demand for greater production (essentially through increased yield and gross cropped area expansion and for delivered water) will further increase. This will lead to still greater competition for water and land allocation among agricultural, industrial and urban uses, thus aggravating externality problems. These trends will require greater attention to demand management.

On the supply side, development of new water resources and lending for this purpose have slowed considerably since the late 1970s. Declines during the decade ending 1990 in Bangladesh, India, Indonesia and Thailand ranged from 15 to 40 percent (Rosegrant and Svendsen, 1993), resulting in a decline in irrigated area growth rates. However, the decline in large-scale irrigation projects was partially compensated by increase in private small-scale irrigation. The large, small, surface and groundwater irrigation systems should be integrated and the choice of system size in a given river basin must be based on conditions unique to that basin and hydrological and aquifer profile. The Green Revolution in Asia was closely linked with the 'groundwater revolution' in the region. Fortunately, the region has still significant untapped groundwater potential. These resources and potentials must be scientifically researched and estimated. Our governments must develop policies and programmes for the conjunctive use of surface water and groundwater.

The extent and quality of land resources should also be mapped and matched with new technologies and production systems. A disaggregated approach of investment in and management of different agro-ecological regimes – irrigated lands, high quality rainfed lands, densely populated marginal lands, extensive agriculture in marginal lands, and urban and peri-urban agricultural lands – will be required. Biotechnology can greatly help in designing new varieties and breeds to match even degraded lands and render them productive. Development of drought resistant crops and varieties will not only reduce the pressure on irrigation expansion but will also improve productivity and profitability of vast semi-arid, arid and other noncongenial rainfed areas, and thus promote equity (Singh, 2001).

On the demand side, land and water policies must be reformed to promote land and water savings through demand management and the application of appropriate technologies. Policy instruments for demand management may include: (i) enabling conditions through provisions of suitable land and water rights and laws to promote investment in and effective management of the resources, (ii) market-based incentives to promote conservation of land and water resources such as

organic farming, appropriate pricing, reduced subsidies on urban water consumption and targeted taxes and subsidies, (iii) non-market instruments, including restrictions, licenses and pollution controls and (iv) direct interventions, including conservation programmes (Bhatia, 1995).

Secure rights to land and water and rights of access to these resources are essential for long-term investment by farmers in land and water conservation and improvement, as well as to enable them to effectively participate in participatory planning, investment and management. Property rights for women farmers should be given due attention as the number of women-headed households is increasing. Local customs, needs and specifics should be kept in mind while anchoring the rights regime, which must have efficient conflict-resolving investment-friendly mechanisms.

Policy support to generation, introduction, assessment and adoption of appropriate technologies will be instrumental in water savings, increasing water use efficiency, soil conservation and improvement of soil fertility and productivity. Micro-irrigation (drip, sprinkler and computerized control systems) saves 40 to 50 percent of water and is free from the problems associated with flood irrigation. In developing countries, water use efficiency is generally low (25-40 percent), whereas in developed countries it is 50-60 percent. Conservation tillage is proving highly effective in soil conservation and fertility/productivity improvement in Latin America. But this technology has yet to find its due place in the Asia-Pacific region where special national programmes should be promoted for conservation tillage. Technology packages to promote integrated soil-water-plant-nutrient systems should be developed and widely adopted on priority basis.

FLEXIBLE, PARTICIPATORY PATHS TO NEW TECHNOLOGICAL, MANAGEMENT AND DEVELOPMENT OPPORTUNITIES

Fast and far-reaching developments in science, technology (biotechnology, information and communication technology), management (e-commerce, regulatory mechanisms), globalization and liberalization, market opportunities and financing mechanisms, call for flexible and highly informed approaches to priority setting, resource mobilization and allocation and linkages. A dynamic approach to accommodate and capture new opportunities – such as those arising from the WTO, new technological products and new information and databases – will ensure necessary changes in land and water management and investment. Often, for example, existing irrigation systems and land use patterns (e.g. rice paddies) are too inflexible to allow crop diversification, thus denying options for other crops and new products to meet new nutritional and economic opportunities. Therefore, while the new irrigation, water and land development plans must have built-in flexibility for diversified production, the old structures will need to be modified accordingly, of course within location-specific economic viability, technological feasibility, social acceptability and environmental compatibility.

National capacities must be developed to assess existing land and water resources and potential and match them with the production, intensification and diversification needs and possibilities, duly internalizing the emerging and modern technologies. Required human resources, research and technological capacities, institutional and organizational support, and needed financial investments must be provided by individual governments to meet the objectives. Based on the assessment of land, water and irrigation requirements, a judicious balance is needed among new irrigation construction, rehabilitation of old and degrading irrigation systems, upgrading and modernization of irrigation, reclamation of degraded lands, opening of new lands, cropping intensity and choice of farming systems. In South, Southeast and East Asia, high population pressure and development demand, means that targeted policies and investments to deal with problems of degradation, restoration, upgradation and preventing further degradation of land and water resources and irrigation systems assume high priority.

Flexibility must also be maintained among choices of schemes. Large dams and large area coverage projects built by the public sector, and small schemes built and operated by public or private sectors (or jointly) have their own economic, social and environmental advantages and disadvantages. The World Bank found that large scale projects were more profitable, but project size explained only 10 percent of the variation in performance (Jones, 1995). Thus, the large versus small distinction is not very useful. Although international support, especially from World Bank, to large dam constructions has greatly reduced, countries must assess their needs and carefully weigh the advantages and disadvantages of alternative options or may wish to strike a dynamic combination of the two. Besides size, the control, management and operation, mechanisms can also be flexible. The inputs of public and private sectors and civil societies for different purposes will vary, but their rational blend may provide greater efficiency and effectiveness.

Government's role in creating large schemes and providing public goods, and instituting and implementing needed agrarian reforms, rights and laws can greatly be complemented by the private sector and people themselves by managing the resources and providing veritable services. This will require significant organizational development and capacity building for farmers' and water users' organizations, and groups and for local governments. Mechanisms to transparently moderate conflicts between different groups of land and water users and speedily resolve problems are essential to ensure desired economic returns and other benefits. Experiences of successful water users associations (WUAs) in organization and management (O&M) of water resources should be analyzed and widely replicated and adapted. Financial autonomy, financial contributions by members of associations and the benefits received by them are all interrelated and should further be forged consistent with the participation, needs and aspirations of small farmers.

INVESTMENT IN LAND AND WATER CONSERVATION AND IMPROVEMENT

Investment in land and water development is essential for food security, poverty alleviation and balanced development. Investments in irrigation during 1965 to 1985 were instrumental (along with the investment in seeds of modern varieties and fertilizers) in ushering in the Green Revolution. During the past decade or so, however, investment in agriculture, land and water, has sharply declined, causing deceleration in agricultural growth. The reasons behind the reduced investments should be examined so that effective corrective measures may be taken to face the challenges of accelerated and sustained agricultural production and productivity – the Evergreen Revolution.

The pattern, nature and management of investment in land and water may need to be changed. Private sector investment must increasingly complement public sector investment. Development of the farmers, by the farmers and for the farmers is increasing and needs support by appropriate policies such as the creation of farmers' associations, community and participatory action, and water users' associations. To encourage various investors, economic, social, environmental and ecological impacts of successful investments in land and water should be critically analyzed and the results communicated to policy makers, farmers, people at large and other stakeholders at national and international levels. Not only the benefits but also the costs of not or under-investing in land and water should be analyzed and made widely known.

Critical land and water degradation problem areas should be identified by satellite imagery and isotopic signatures. Investment in reclamation and rehabilitation of such areas should receive priority attention. Investment opportunities include creating biochecks to control soil erosion, developing windbreaks (widely adopted in China), terracing, building up organic soil matter, installing small-scale irrigation systems and pumps, and creating water harvesting devices. Such investments and management activities should be done in close partnership of public and private sectors, farmers, researchers, extension workers, and non-governmental organizations. Institutional supports, such as credit, subsidies ('smart subsidies' granted by using carefully selected criteria),

extension and community-based organizations will be needed to effectively organize and manage such investments. Subsidies as co-investment in increasing the productive potential of land and water should be encouraged.

More investment in land and water research, technology development, information systems

Research and technology development agendas for land and water must be broadened to address not only agro-physical and agro-biological issues but also socio-economic, environmental and ecological issues to ensure the congruence of enhanced productivity (efficiency), sustainability, profitability and equity. Only such an integrated holistic and system-based research and technology development approach will concurrently satisfy the various stakeholders, namely, the farmers, environmentalists (the "Green" lobby) and the public at large. Research and development (R&D) paradigm shifts must emphasise interdisciplinarity and multidisciplinarity rather than monodisciplinarity. The process is also the goal and not simply the product, system-based not just commodity-based, and people-and-environment-driven and not technology-driven. Such R&D systems are complex and demanding. Besides increasing R&D investments to meet such complex challenges, institutional supports and human resources must be adjusted to establish and manage linkages at national and international levels. To ensure informed investment and resource management, suitable indicators must be developed to identify economic, environmental, ecological and social costs and benefits. Policy research capacity, including socio-economic research capacity, must be strengthened in many R&D systems. Research and development staff must collaborate with policy-makers and planners.

In recent years, national and international agricultural research institutions (particularly CGIAR) have allocated larger proportions of their budgets to natural resources management (Alex and Steinacker, 1998). But this has often happened at the cost of equally important areas. Thus, there is a need to explicitly allocate additional funds to land and water resources commensurate with the priority. Work programmes should clearly identify multidisciplinary and multi-institutional activities and allocate resources specifically for the purpose. Concerned institutions must have capacity to value natural resources and analyze environmental impacts – costs and benefits to justify as well as to monitor the efficacy of the investments. Because of multidisciplinarity and multi-component technology packages and the emphasis on bottom-up and participatory approach, the extension and technology assessment and diffusion system will need to be overhauled and suitably trained human resources will be needed. The Asia and Pacific region leads the world in the development and widespread adoption of IPM technologies, including the Farmers' Field School (FFS) initiative. Asia should use this experience by investment and management of land and water resources. The indicators and methodologies developed by the International Water Management Institute should be internalized in national Natural Resource Management Research (NRMR) programmes.

The impact of land and water R&D investments and management is closely linked with the nature and availability of information on the status and prospects of the resources. The need to increase the awareness of the status of land and water degradation, availability and improvement issues among policy makers, investors and the broader society can hardly be overemphasised. Recent revolutions in GIS, information and communication technologies must be harnessed for collecting and sharing information not only on the resources but also on available technologies, market conditions and socio-economic settings. Information networks must link the farmers, community groups such as landcare groups in Australia, local governments, extension and research organizations, climate and weather forecast centres, market and input output distribution centres and planners, and executors and policy makers.

Indigenous technologies and knowledge should form an integral part of databases. Public and private sectors should invest not only in necessary hardware and software but also in human resource training and development. Soil and water clinics in rural areas should be linked with rural agricultural

information centres which must constitute an integral part of the national agricultural information system. International organizations such as FAO, UNEP, CGIAR centres, including IWMI, and the global and national Soil and Terrain Digital Database (SOTER) programme have established dynamic and comprehensive databases. The national and international databases should be linked for deriving maximum mutual benefits. FAO should strive to harmonize various indicators, methodologies for environmental and ecological accounting and data collection formats for standardizing the information collection and interpretation procedures.

EPILOGUE: NATIONAL VISION ON INVESTMENT IN LAND AND WATER

Each nation must have a vision statement on the investment in land and water. This should be based on the present and future needs of food and agricultural production and productivity and the national and global opportunities. Each nation must assess the extent of cultivated land and irrigation it should have to meet its goals. The extent, status and potential of the resources must be mapped systematically and scientifically and matched with the people's aspirations, national capacity, and development objectives. Based on this, will emerge explicit targets and policies and sectoral and subsectoral priorities for investment in land and water resources.

Each country should have clearly defined rights to land, rights to water, and necessary laws. If not there, these must be developed and transparent agrarian reforms should be undertaken. The fundamental need for transparent governance of the natural and monetary resources and implementation of the rights and laws can hardly be over-emphasized in context of flow of funds, especially from external sources. Specific policies for promotion of public and private sectors' investment, loans, credit and subsidy ('smart' subsidy) with special consideration of need and prospect of small farmers, and the provision of necessary institutional and infrastructural support need to be in place simultaneously. In their negotiations under the WTO Agreement developing countries must structure the 'green box' or if necessary introduce a 'food security box' in the Agreement, to protect the interests of small farmers.

Who would have predicted that the world would not be the same after 11 September 2001 – at least in the short to medium term. World Bank President James D. Wolfensohn estimated that "tens of thousands more children will die worldwide and some 10 million more people are likely to live below the poverty line" of US$1/day because of the attacks and that many more will be thrown into poverty if development strategies are disrupted. He said that "20 000 to 40 000 children under five years old may die from the economic consequences of the September 11 attack as poverty worsens" (***Bangkok Post***, 2 October 2001). Mr Wolfensohn further cautioned that developing countries GDP growth could be cut by 0.5 to 0.75 percent and developed countries by 0.75 to 1.25 percent in 2002 due to the impact of the terrorist attacks.

Will investment in agriculture be further depressed due to the September 11 tragedy? It must not. The silent violence of hunger and poverty is a killer of a much bigger proportion. As Chilean poet Gabriella Mistral has so eloquently reminded us all, the hungry child cannot wait. his bones and sinews are being formed now. You can't tell him tomorrow; his name is today.

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Investment in land and water in the context of the Special Programme on Food Security

THE SPECIAL PROGRAMME ON FOOD SECURITY

On the basis of a desk review of Special Programme on Food Security (SPFS) projects, this paper presents findings, reviews constraints, and examines how water control, soil management and plant nutrition issues relate to other aspects of the SPFS and to the goal of ensuring food security for all.

FOOD SECURITY AND SUSTAINABLE LIVELIHOODS FOR THE RURAL POOR

The FAO definition of food security is: "a state of affairs where all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". An estimated 800 million people worldwide suffer from malnutrition although food is not scarce at the world level. Food insecurity is a problem of lack of access resulting from either inadequate purchasing power or inadequate productive resources needed for subsistence. Other causes of food insecurity are drought, conflict, poverty, population growth, poor economies, and failures in governance and in aid. Rural areas have specific problems with fragile ecosystems, low productivity, neglect of pastoralism, narrow livelihood bases, weak infrastructure, few social services, and slow response to alerts. Resource-poor farmers have seen few benefits from economic liberalization, and financial markets view them as poor credit risks.

A livelihood encompasses income in cash and kind; social institutions such as kin, family and village, gender relations and property rights; and access to education, health services, roads, water supplies and other social and public services. It is sustainable when it can cope with stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.

AIMS AND COMPONENTS OF THE SPECIAL PROGRAMME ON FOOD SECURITY

The SPFS is a principal strategy of FAO. It seeks to help low-income food-deficit countries (LIFDCs) improve their national and household food security on an economically and environmentally sustainable basis. It aims to promote rapid increases in productivity by small farmers in food production and other rural activities, reduce production fluctuations and improve food access through increased household incomes.

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SPFS provides an opportunity to test innovative approaches on a small-scale with a view to their wider replication. The SPFS belongs to and is the responsibility of the participating countries with FAO acting as an international facilitator and catalyst. Its eventual success will depend on governments' willingness to establish a political, social and economic climate conducive to agricultural growth and the alleviation of rural poverty.

The guiding principles of the SPFS are national ownership, a focus on high-potential foods and areas, participation, environmental awareness, and regard for the role of women. The SPFS approach emphasizes participation and building partnerships at all levels. It aims to involve all persons with a role to play: government officials of beneficiary and donor countries; scientists; extension workers; private traders and entrepreneurs; experts from intergovernmental agencies and NGOs; and farmers. It seeks to exclude no social group and to create no inequities and it attaches great importance to promoting the flow of information and knowledge to poor people. The SPFS generally endeavours to equip poor smallholders with productive assets in order to help them realize their potential.

The SPFS began in 1995 and is now operational in 60 countries (36 in Africa, 13 in Asia, seven in Latin America and two in Oceania). It consists of two phases: pilot (Phase I) and expansion (Phase II). Phase I involves demonstrations on farmers' fields in selected areas within a country. These aim to: introduce farmers to innovative practices; enable participation in the evaluation of the technologies and management practices; identify and overcome obstacles to their adoption. Where reliable water supplies are unavailable, SPFS envisages the introduction of low-cost irrigation and drainage systems, together with better storage systems and land use practices to conserve water. When it begins, Phase II intends to create the environment for large-scale replication of development approaches that have proved successful.

Phase I has four main interrelated and complementary components: water control; crop intensification; diversification of production systems; and constraints analysis and resolution. The focus on water control reflects the fact that timely water availability is crucial for plant development. With some investment and knowledge, many farmers could use water to safely increase the yield, quality and timeliness of crops. Water control entails complementary measures for intensification and the proper maintenance and operation of infrastructures. The diversification of production systems recognizes the complexity of farming strategies and the need to develop ways of generating income, and the benefits of a more diversified nutrition. The constraints analysis process feeds back into Phase I and forwards to Phase II.

Water control

The SPFS focuses on the technologies of farm production including small water supplies under the control of farmers, such as furrow irrigation, pump systems and small water harvesting systems. Such decentralized production systems depend on a few centralized services to supply credit, seeds, animal disease diagnostics and pest control techniques.

Although in principle water is a public good, the 1992 Dublin Statement states that "water has an economic value in all its competing uses and should be recognized as an economic good". Privatization is increasingly denying the poor access to water, especially for irrigation. The SPFS supports water appropriation by the rural poor to make their livelihoods less vulnerable, and to anchor their water rights in the law.

Realizing the potential of water control for self-employment and wage-employment by the rural poor requires thorough investigation, in particular with regard to gender equity.

The impact of a water control project on the nutritional situation of the community is not easy to demonstrate in a quantitative and objective way. The ultimate measure of a project's success is the associated change in the nutritional level of the community. However, indicators of better nutrition require considerable time to become significant and meaningful.

Crop intensification and production system diversification

Agricultural intensification requires increased flows of nutrients to crops, a higher nutrient uptake and higher stocks of plant nutrients in soils. However, unless implemented properly, intensification can cause nutrient depletion, threaten biodiversity, increase erosion and, ultimately, environmental degradation. Without nutrient inputs, agriculture in the tropics results in nutrient mining. Thus, the SPFS project report from Guinea underscores the need for soil fertility management. Plant nutrition management depends largely on prevailing economic and social conditions. Farmers' decisions depend on their economic situation and socio-economic environment; their perception of economic signals; and their acceptance of risks. Plant nutrition management can contribute to food security and to sustainable crop production.

Optimizing the management of plant nutrients while maximizing incomes for farmers within the local economic context entails local-level decisions on the management of and investment in local sources of nutrients (vegetation and livestock). The major aspects are: assessment of nutrient requirements; choice of sources and methods of supply; determination of the level of domestic fertilizer production required; price levels and subsidies for plant nutrients; legislative aspects; and technical support. Policy-making in these areas determines the extent to which farmers have access to plant nutrients and are able to increase their production while maintaining soil fertility. A farmer needs purchasing power to obtain external inputs, and advice on how to use them in a balanced way. In remote areas of developing countries, poor farmers lack purchasing power, mineral fertilizers are expensive because of transport costs and intermediaries, good advice is hard to obtain, and fertilizer subsidies have widely disappeared as a result of structural adjustment (FAO, 1998).

A concern in the SPFS is to overcome the yield gap (the usually considerable difference between per hectare yields in the food-challenged community and in experimental fields under controlled conditions). Among the reasons for this yield gap are: (i) government cuts in support for agricultural research (IFPRI, 1999); (ii) privatized research geared to farmers who can pay royalties rather than to subsistence farmers; (iii) limited research into crops grown in the tropics; (iv) constraints such as production costs and marketing.

Research-developed crop varieties need tending to in a particular context: the "technology package" surrounding the application of the selected seeds and ensuring the development of their potential. The main factors supporting the crop are water management at the root level, plant nutrition and pest protection. In Phase I, the SPFS tests and demonstrates the benefits of using improved seeds while adjusting the package to local conditions. If successful, the technology spreads to use by farmers who have had an opportunity to evaluate its application in their own household context.

Agricultural intensification and diversification have led the SPFS to support cash crops as a flexible way of improving nutrition, in particular for infants, and of facilitating children's access to education. A diversified productive base, such as in the "field, pond and stable" approach in Southeast Asia, enhances household food security through a more intense use of the available assets, availability of more varied food, and the added ability to generate cash. Such systems are easily internalised, in particular when they offer an opportunity for women to employ their time more effectively. For example, freeing them from carrying water from distant sources can have a positive nutritional impact as they can apply more time and energy to productive activities.

Many urban poor and underemployed resort to the street trade of food though often beset by hygiene and health hazards and lacking suitable land, safe water and adequate inputs. Phase I has evidenced the links between rural and urban poverty and the need for coherent food security policies. Consequently, SPFS activities have incorporated urban and peri-urban agriculture.

PROJECT FINDINGS AND CONSTRAINTS

This section presents project-specific data from initiatives in Africa and Asia (Boxes 1 and 2).

A Senegal case study

A study carried out in Senegal (Sonko, 2001) identified factors that contribute to food insecurity in the context of a rural village: (i) *Lack of landownership.* Obstacles include: high population pressure, land parcelling, difficulties in reaching remote land, settlement of borrowed land (owing to migration), social status and gender; (ii) *Social disintegration*. Disintegration of social culture in general and of the family in particular; (iii) *Credit access difficulties.* Chronic debt related to former financing mechanisms has removed capital from the rural economy; (iv) *Lack of employment.* Little development of off-farm employment opportunities; (v) *Conflict and insecurity.* Some production activities are risky because of low prices, floods and other contextual hazards; (vi) *Disability and old age;* and (vii) Macro-economic and structural adjustment-related policies may penalise rural activities.

Subsidized support tends to leak to the non-poor, where it is less effective in improving food security. For example, the Senegal study of sustainable livelihood approaches in the SPFS examined the situation at the Saré Bouka demonstration site. Ranking people by wealth, it found that 70 percent of those considered rich (19 percent of the population) received poultry, whereas only 22 percent of those considered poor (50 percent of the population) benefited from the programme. In the context of this village, the rich are people that fulfil their food needs over the year and have some surplus. Most of them have agricultural equipment and are able to recruit temporary workers. Some of them own businesses, save money, lend money or goods and have stocks of merchandise and provisions. Diligent monitoring and conservation can prevent the flow of project resources to the non-poor.

A Tanzania case study

Small-scale rural producers may apply over 80 percent of their household product to meeting their basic food requirements and their livelihood strategies may be complex. For example, a joint FAO/DFID analytical study of the application of sustainable livelihood approaches to SPFS (Temu, 2001), carried out in areas of Tanzania vulnerable to food scarcity, identified strategies that include: (i) providing casual labour against payment, often at distant places; (ii) engaging in off-farm activities such as brick making, quarrying and brewing; (iii) consuming alternative foods, e.g. roots and tubers; (iv) seeking help from the extended family; (v) borrowing food or money; and (vi) reducing food intake. The first three options are common to most livelihood strategies, while the last three relate to a state of food distress. Households on the brink of food insecurity have no savings and limited or no access to credit, and any failure in their strategic enterprises may result in acute food insecurity, dissolution of the household, emigration of the stronger and starvation of its weaker members. Such households adopt conservative risk management strategies and are averse to engaging in any speculation as long as their food supply is not secure.

A nutritional impact survey carried out in Tanzania during Phase I enabled better planning of Phase II (Egal, 2001). In Mali, the failure to conduct a preliminary study had a negative impact on certain social groups. The Tanzania study found no explicit documentation to indicate the undertaking of in-depth surveys and research to establish the food security status and vulnerability in the project

area. With decisions based on secondary information and without a full understanding of economic and social forces, action will remain haphazard.

The FAO/DFID study found that current land tenure arrangements provide little incentive for smallholders to fully adopt the SPFS-recommended technological packages. Farmers highlighted problems of conflict between herders and crop producers. Other problems stemming from land tenure include apparent lack of concern to improve the quality of land by investing in it, and also failure to conserve it by measures such as fire prevention, erosion prevention, proper management of water catchments and tree planting.

In Tanzania, the participatory approach was advanced through: (i) formation of homogeneous social economic groups (Participatory Farmers Groups, PFGs); (ii) a participatory process of identifying production constraints; (iii) participatory selection of appropriate production technologies; (iv) farmer training to enable full participation in technology dissemination; (v) creating understanding and acceptance of the programme through awareness and sensitization about SPFS; and (vi) orienting training of village extension workers and equipping them with participatory techniques and relevant technologies. Interviews with officials indicated that the approach recommended in the "Guide on Participatory Group Formation" was valid and succeeded in promoting farmer participation.

CONSTRAINTS, SHORTCOMINGS AND HOW TO DEAL WITH THEM

Productivity gains depend increasingly on human resources. Professional training and integration of farming populations into the process of development must accompany improved health, nutrition and literacy levels. In this regard, Phase I tackled some activities originally envisaged for Phase II, such as farmers' field schools. A number of points emerged. For example, technical solutions must be integrated with local issues to provide solutions for resource-poor communities. In very diverse social, economic and ecological environments, technology packages must be diverse and adaptable. Extension staff need to be aware of the technology and the specific needs of their communities. However, extension staff is often poorly prepared in terms of new technology skills and knowledge and their transfer. This handicap, coupled with poor motivation due to low salaries and status, may make them reluctant to face farmers. Extension staff should be a first target for training.

Within the SPFS, water control for irrigation focuses on simple low-cost technologies and involves other specific aspects such as institutional capacity building, promotion of support activities, and integration with other components. Success hinges on group formation and farmer participation in irrigation scheme maintenance, the promotion of relevant technologies and partnership arrangements. The need for multidisciplinary teams to support extension workers has emerged. Unsatisfactory farmer participation in various stages of technology transfer often points to a persisting weakness in the approach. Reporting on irrigation activities should include such aspects as irrigated land increases and cropping intensity improvements.

There is a need to demonstrate that water is a major constraint, to fully determine the level of subsidies in irrigation, and to gather more data on technologies and returns to investments. For example, in Tanzania, Phase I showed farmers in irrigated demonstration areas how to double yields by using improved seeds at the proper planting dates, applying fertilizer, spacing plants properly, and protecting soil and water. Although the exercise was successful, it did not provide a breakdown of the efforts and rewards at the household level derived from the use of irrigation. In Malawi, people interested in irrigation farming faced the problem of access to communal land. Most of the land belongs to particular individuals and unless genuine cooperation exists, using borrowed land for group farming usually results in conflict. There should be a critical assessment of landownership before

selecting sites for smallholder irrigation. Land tenure problems also exist in Nepal, where good irrigable land is underused while landless farmers are forced into temporary emigration.

In Pakistan (Box 1), zero tillage technology saved irrigation water and reduced tillage operation costs. In Bangladesh (Box 2), the best practice in channel management decreased pumping costs by 25 percent. In Bolivia, the technique reduced erosion on land that intensification had rendered highly exposed. An important criterion was that the same land could be used for pasture before and after the cropping season.

Human resources

Women

Rural women often have a threefold role within a household: child-rearing, household management and income earning. Women's share in the labour force is generally high in countries where land availability and income per agricultural worker are low. For example, in Zimbabwe's communal areas, women constitute 61 percent of the farmers and at least 70 percent of the labour force (FAO, 1996). Comparative studies of the productivity of irrigated plots in Burkina Faso (Zwarteween, 1997) and in Senegal indicate the higher productivity of female-managed plots. In Mali and Tanzania, entrusting women with marketing and managing the returns resulted in net benefits in child nutrition.

In Ethiopia, the SPFS includes 160 sites with over 30 000 participating farmers, more than 50 of them widows. It would thus appear that other women are supposed to participate through the male head of the household. The participation of women in PFGs in Tanzania ranged from 49 to 19 percent. At a national SPFS workshop in Kenya, the 29 field staff was all men. This aspect requires further action, as achieving better nutrition without the full participation of women will be difficult.

Developing the sensitivity and capacity of SPFS staff so they can address inequity towards women and focus on supporting women's role in food supply and nutrition can have a large impact on its effectiveness, especially in reducing malnutrition among children. However, gender discrimination tends to remain entrenched. Participation in the information gathering phase should involve the stakeholders, that is, women in food-challenged households. The same cultural patterns that result in gender inequity often also make it impracticable for male agents to collect and cross-check the relevant information. Among the subjects in any investigation are land tenure arrangements, water allocation to female-headed households and the non-agricultural uses of water that alleviate the workload and improve health and nutrition for poor women and children. In order to target poverty alleviation and nutritional improvement effectively, the SPFS needs gender-integrated teams.

BOX 1
Special Programme for Food Security in Pakistan, 1998-2001

Objectives:

- supplement national efforts to increase food production through enhancing crop productivity;
- ensure food security and alleviate poverty at village level through improving productivity and income of small farmers;
- build a sustainable model to ensure continuity of the food security programme.

Phase I: operational in two pilot villages since August 1998 (and one other since August 1999). Approach: participatory – farmers' leadership and participation in all field activities. Focus: small farmers (large farmers restricted to 12 acres for input provision from the project). Water Users' Associations established and federated in a Village Organization. Phase I completed end July 2000.

Phase II: completion of ongoing activities in existing pilot villages and start-up at two new pilot villages with the objective of training local manpower to extend the project model to other villages.

Programme components:

- water management (watercourse improvements, furrow bed irrigation technology, precision land levelling with laser technology, farm redesigning and planning, water scheduling and minimal tillage technology).
- crop management (improved and certified seeds, balanced fertilizer application, plant protection measures, modern farming technologies and machinery, and crop diversification).
- income diversification (small-scale rural poultry farming, bee-keeping, agro-forestry; growing off-season vegetables; fish farming at farm level; and production of certified seeds).
- human resource development (group extension approach; training in production technology for farmers and field staff of agriculture extension and on-farm water management departments; benchmarks established at village level).
- socio-economic constraints analysis (at village, district, provincial and national levels).

Food crops such as wheat, maize, rice, oilseeds and pulses are the main focus of the programme. Provincial governments have provided manpower and technical services assist farmers at their doorstep. For ensuring future sustainability**,** each village now has an input sales centre, farm services centre and revolving fund account under the supervision of the Village Organization.

Farmers pay 100 percent cost of inputs (50 percent at delivery and 50 percent after harvest). For implements, farmers contribute 50 percent and the programme pays the rest.

Crop productivity: Under this project, wheat productivity increases (compared with the benchmark value) in the pilot villages ranged from 28 to 51.5 percent for the first crop and averaged 62 percent for the second crop with a maximum increase of 168 percent, while for rice the productivity increases were 26.7 percent (first crop) and 50.3 percent (second crop) with a maximum of 125.6 percent.

On-farm water management: Furrow bed planting of wheat has given a 13 percent higher yield than with flat bed sowing and a water saving of 22 percent compared with the flood irrigation system. Zero tillage technology has penetrated the rice-wheat system and have farmers bought 50 drills at their own expense.

Income diversification: The SPFS pilot project provided 500 birds and a poultry shed. The farmers then built seven more sheds for 12 000 layer chicks resulting in an 11-fold increase in poultry shed area and a 24-fold increase in the number of chicks within one year. From bee keeping, each farmer has averaged a profit equivalent to that from 2.4 ha of wheat, 1 ha of cotton and 2 ha of rice. Farmers have started fish farming at their own expense.

Revolving fund accounts ensure project sustainability, and at some site farmers now rent out their farm implements, so enabling a permanent source of income and access to all kinds of implements.

Many project agents (national and international civil servants, consultants, experts, technicians and extension agents) are reluctant to venture out of their assigned field. Their assumption that others will combine all the elements to improve the nutritional situation is often mistaken and project benefits may accrue, not to the targeted group, but to the non-poor.

Another problem is the communication gap between poor farmers and researchers. Extension services are understaffed, often with ill-prepared, poorly paid and unmotivated staff. The Tanzania study points out that the delivery of extension services has been weak, while the PFG relies heavily on extension services for the dissemination of technological packages and conducting on-farm demonstrations. New approaches and commitment are needed to ensure that farmers benefit from technological innovation.

Elitist tendencies are common. Non-local people find it is easier to deal with the more educated or cosmopolitan locals. But, the task is to ensure that every member of the community has internalised the pros and cons of the envisaged actions and the benefits and obligations of participation. Consensus then needs to lead to action, but not every community has the leaders and the team to do this.

A critical aspect in some projects is that local manpower is not familiar with the technicalities of on-farm water management. However, it is difficult to assess the extent to which training helps overcome constraints. Trainees attend courses because they feel the need for training in order to properly apply the knowledge to securing their livelihood. However, during the high agricultural season, farmers may prefer to tend to their fields. In rural areas with high seasonal or permanent underemployment and disguised employment, the prospect of receiving a financial benefit in the form of a training allowance may attract participants. This may lead to applying limited financial resources in an unsustainable and unsound approach.

Financial, organizational and technical constraints

Credit, funding and the private sector

Large global and regional development banks are available to support government development efforts. However, in conventional banking, small producers are not creditworthy, or the business is too small to justify the transaction costs. Small farmers need more innovative forms of banking. In cohesive communities, small farmers groups can provide collateral, while loans in kind can help overcome practical difficulties.

Within an adequately implemented regulatory framework, the private sector should be increasingly responsible for investments and services such as input provision, credit and marketing services, and the development of agro-industries. However, private investment in agriculture is seldom pro-poor. In many developing countries, traders provide marketing and credit services to farmers that lack access to a market within reasonable distance. However, traders tend to take a monopolistic position, are generally unable to supply technology and unwilling to finance infrastructure. This system leaves farmers no margin for capitalization. For many subsistence farmers, fertilizers are unaffordable. Pesticides are a health hazard as farmers lack training in their use. Under such circumstances, employment generation for unskilled local people is low quality and minimal. Lacking an adequate public policy framework, the potential of the private sector to improve incomes and food security remains underutilized.

BOX 2

Special Programme for Food Security in Bangladesh

The On-farm Water Management Pilot Programme became operational in July 1999.

Objectives:

- demonstrate and pilot farm-level water management procedures and techniques consistent with farmers' needs and ensure the sustainability and participative management of surface water.
- develop and test procedures to strengthen the capacity of authorities and local NGOs to provide effective support to farmers to improve on-farm water management (OFWM) and to intensify crop production.
- monitor and assess programme effectiveness and prepare recommendations on how to expand the pilot demonstrations into national and regional development programmes.

Activities implemented:

- Participatory rural appraisal.
- District workshops and first national workshop.
- Technical staff training, farmers' seasonal training, farmers' field school and technical field training.
- Pilot demonstration programme with main crops included (i) OFWM improvements and (ii) crop husbandry techniques and technologies adapted to the specific conditions.
- Community development with local NGOs.
- Women's group training.

Achievements:

- On-farm water management - (i) delineation of manageable irrigation blocks, (ii) improvement of the distribution systems, (iii) irrigation scheduling and (iv) supplementary irrigation of rice.
- Best practice in channel management - command areas increased 20 percent; pumping costs decreased 25 percent.
- Crop demonstrations - new crops and varietal shift for agricultural diversification, improved rice nursery, line transplanting of rice, green manuring, balanced fertilization, integrated pest management and small pond fish culture now adopted at pilot sites and adjoining areas.
- Training for capacity building, skills development and empowerment - involving women
- Community development and women's development training - water user groups and associations formed with groups for women.

The main problems small farmers have with input supply and output marketing relate to: enabling policy for private sector marketing; rural infrastructure investments; extension services; market information; and adequate post-harvesting handling and storage. Small farmers, rural traders and extension staff need improved business skills. Within a competitive environment, stable relations between farmers and the private services sector are advantageous. In the Kauti district of Kenya, for example, a wholesale exporter collects French beans produced by smallholders, but there is no formal contract, the exporter does not always take all the harvest and does not provide credits for inputs.

Organizational and technical aspects

Many countries have been slow to set up a national SPFS steering committee. For example, although Burkina Faso committed itself to implementing the SPFS in 1995/1996, in June 1999, while work in the field was advanced, there was still no steering committee. In Tanzania, owing to what may be an overly bureaucratic structure, senior officials and committees have minimal direct influence on farmers' activities. However, senior managers accept and support farmer ownership of the process. The success of Phase I was due to the active participation of stakeholders at every stage. Various stakeholders (farmer's groups, input suppliers, credit institutions, research and extension officers, regional and district policy-makers and authorities) participated in identifying key issues and, at a

later stage, implementation approaches such as increased production, project financing, technology, expertise and human requirements, and information needs.

In Angola preliminary studies carried out by persons unfamiliar with the reality of the project region failed to provide the information required to formulate a work plan. It is necessary to establish preliminary contacts with the communities in order to identify and address problems that have immediate solutions, and so gain their trust. This makes it possible to obtain a clear picture of the existing socio-economic reality and a list of families, useful for defining the interventions and enabling participation. It is also essential to establish freely elected and recognized (by traditional and political authorities) community development committees which should be active in the planning and execution of all actions.

The full integration of infrastructure and rural development is essential. Projects aimed at water control infrastructure development alone have limited chances of benefiting the poor before they benefit the non-poor.

Although the privatization of public goods, such as knowledge, may aim to improve dynamic efficiency through greater innovation, a loss of static efficiency may result from thwarted competition and the underuse of protected knowledge (Stiglitz, 1999). The SPFS projects do not appear to have used copyrighted seeds, possibly because they are not relevant to the needs of the rural poor. Traditionally, farmers save selected seeds from one growing season and plant them in the next, and in this way are sure of using locally adapted varieties.

Rural people's skills may no longer be appropriate under changed conditions, but farmers are wary of changing traditional farming methods and need exposing to new techniques without their carrying too much risk. Applying technology to transform agriculture and raise incomes is at the heart of most development assistance in this field. The major problems are not technical but concern reaching agreements on facts, alternatives or solutions. Technology can contribute to economic growth by overcoming resource scarcities and by combining products and inputs to optimise output. However, complex, diverse and risk-prone production environments call for adaptive designs and strategies. Many technologies address single commodities and specific forms of production, such as rainfed or irrigated agriculture. In reality, farming households pursue a range of production activities, which may include spatial diversification to ensure food, fire, shelter and health. Designing support services to cater to such diversity is difficult.

Phase I highlighted other development constraints and problems. They included having open and porous borders with large and relatively developed countries; inappropriate donor policies and dependence on donors; misplaced national priorities; and administrative instability. Also, farmers abandoned newly introduced subsidized cropping patterns once the FAO-recruited team withdrew; there were shortages of seeds and planting and propagation materials (centralized systems of input production, procurement and distribution failed to cater to local needs); and there was a paucity of technical and economic information related to irrigation based on actual experience and observation as well as the fragmentation of holdings.

SPFS has been subject to specific constraints and issues. FAO recruited staff may be operating in a different regime of rewards and incentives, or parallel to the existing network of agricultural research and extension services. Such factors and the associated issues of replicability and sustainability are the principal SPFS-created constraints that may seriously jeopardise its expansion.

Another SPFS-specific constraint relates to the doorstep delivery to farmers of inputs either free or at heavily subsidized rates. An efficient and effective input distribution system is essential to any development programme. The priority national policies attach to rural roads, technology systems,

etc. is a testimony to the recognition of these prerequisites. However, the means and style adopted in actually implementing the SPFS may be at variance with its own and national goals. The SPFS approach of delivering key inputs itself or through seeking special favour is contradictory and can become a major SPFS-produced constraint on the programme's expansion as it is neither replicable nor sustainable. Instead, it should explore ways of improving existing institutions and systems.

CONCLUSIONS

There is general agreement that the provision of food security has to start from the household level. Changing the agricultural structure of developing countries while promoting sustainable livelihoods for rural people and reducing poverty requires a long-term commitment. However, as international instruments erode governments' capacities to implement national policy objectives, national efforts need supporting in a context of food security as a global public good. Food security and rural development are essential precursors to prevent environmental degradation.

SPFS has demonstrated that investment in land and water can promote agricultural intensification and diversification. The resulting sustainable productivity gains can improve household incomes and livelihoods, provided certain identified constraints are overcome. Overcoming such constraints usually requires funds, be they on long-term credit, on concessionary terms or grants. To generate funds, it will be necessary to prepare small, well-designed food security projects with concrete goals and reasonable overheads. Such projects will need to demonstrate what inputs are needed to obtain the results that the stakeholders desire. The results of such projects need to have an immediate and clear relation with the improvement of livelihoods and food security. Reporting changes in the nutritional situation may not be practicable in every case, but nutritional impact surveys and monitoring can provide proof that the SPFS is having an impact where it matters. Transparent implementation of the SPFS and an accurate monitoring and reporting system are preconditions for acquiring credibility. The capacity to generate, analyze and report the necessary data needs strengthening. A key role for FAO lies in collating and disseminating the critical information in a reliable way.

A lesson from the SPFS project in Guinea is that, before launching the project, institutional partners need to provide adequate and timely information at the field level in order to ensure that partners such as farmers' groups buy into it. The project identified a need to strengthen the capacity to monitor, evaluate and analyze the economic viability of proposed packages. Rural development specialists are a key element in establishing the capacity and professionalism of the SPFS teams.

Incorporating nutritional impact surveys in the SPFS planning process can help direct project benefits to improving the nutritional situation of the poorest households in the target community. There should be a special focus on understanding the role and functions of women in the household, as any action leading to increased effectiveness in family nutrition can free time for other productive tasks. Severe conceptual and methodological biases have undervalued women's role in agriculture. On the other hand, however, the experience with the SPFS shows the potential to improve upon tenancy rights and contract farming opportunities in some countries as significant developments.

In conclusion, land and water investments are essential components of an approach that seeks to ensure sustainable food security. However, small-scale project success and wider replication will depend on managing all pertinent aspects of investment in water (e.g. irrigation, drainage and water management), land (e.g. plant, nutrient and soil management), human resources and infrastructure in a dynamic national and international context.

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The benefits of investment in land and water

INTRODUCTION

Agriculture and the rural sector remain vital to pursuing the related goals of food security, poverty alleviation and sustainable development.

Increased agricultural output will have to come mainly from intensified rather than extensive production as per capita land and water resources diminish. This implies continued productivity gains in the use of these two primary resources and factors of production.

Such increases in productivity will require increased investment in agriculture, and especially in land and water development. However, investment in these areas is decreasing or at best stagnating. Governments, authorities and development practitioners are thus facing the paradox of having agreed to development goals requiring increased production with diminishing per capita resources, but without the concomitant investment to do this.

This paper examines this apparent contradiction from a perspective of land and water. It focuses on land and water as finite resources and factors of production on which productivity-increasing technology in agriculture depends. While dealing with land and water in parallel, it also recognizes their interrelationship and complementarity. The emphasis is on irrigation because of its prominent role in food production under intensive systems and because it is the largest consumer of water in agriculture and in overall water use. The paper also examines ways in which land and water interrelate under less-favoured rainfed conditions to improve productivity. The overall theme is that of why investment in land and water development is essential for food security, poverty alleviation and balanced development in developing countries.

LAND AND WATER AVAILABILITY

Together with labour and capital, land and water constitute the aggregate resource base for agricultural production. Their association with appropriate types and levels of labour, capital and technology enhances their productivity in agriculture. Thus, their availability is central to development, food security and poverty alleviation.

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Land availability

According to FAO estimates, about 30 percent of the world's land surface is suitable for rainfed agriculture. Of this area, some 2.8 billion ha in developing countries have the potential for growing rainfed crops above an acceptable minimum level. With 960 million ha already cultivated, this leaves 1.8 billion ha for further expansion (FAO, 2000a).

However, the utility of this reserve is limited as about 90 percent of it lies in seven Latin America and sub-Saharan countries. Furthermore, much of the land suffers from constraints such as ecological fragility, low fertility, toxicity and lack of infrastructure. Human induced land degradation such as soil erosion and salinization is also a factor.

The projected expansion of arable land for crop production in developing countries by 2030 is about 120 million ha, with the bulk of it in sub-Saharan Africa (57 million ha) and Latin America (41 million ha).

FAO estimates that between 1995/7 and 2030 about 80 percent of the projected growth in crop production in developing countries will come from intensification in the form of higher yields (69 percent) and cropping intensities (11 percent), with the remaining 20 percent coming from arable land expansion. The share due to intensification will exceed 90 percent in land-scarce parts of the Near East, North Africa and South Asia. In the preceding 34 years 76 percent of the growth in crop production was due to intensification (71 percent from higher yields and 5 percent from higher cropping intensity), and 24 percent from arable land expansion. Intensified production occurs mainly on land already under cultivation (FAO, 2000a).

Water availability

The major problem with water is not its quantity but its uneven distribution in time and space. The combination of uneven distribution and expanding population is increasing the pressure on water resources in various countries, mainly in Africa and the Near East. In 1995, 29 countries with populations totalling 436 million experienced water stress or scarcity. By 2025 the corresponding figures will be about 48 countries and more than 1.4 billion people, most of them in the least developed countries (World Bank, 2001). Moreover, such data do not show how countries with ample supplies of water relative still experience shortages in many localities, e.g. China and India.

Increasing water scarcity will result largely from rapidly growing demands for agricultural, industrial and household purposes. At the same time, the potential for expanding supplies in many countries and localities is diminishing. Deteriorating water quality and environmental conditions, degradation of irrigated land, insufficient river flow, upstream land degradation and seasonal flooding will aggravate water shortage problems. Unless there is prompt action, developing countries risk severe water shortages that could depress agricultural production and limit industrial and household use (IFAD, 2001).

The threat to agricultural production is particularly severe because this sector accounts for 80 percent or more of total water use in many developing countries (Yudelman, 1994). As irrigation is the largest user of water (often at highly subsidized rates), attention needs to focus on improving its generally low water use efficiency levels.

IRRIGATION

By ensuring a regular and timely supply of water, irrigation reduces the risk of crop losses from uncertain rainfall and enables production in areas or at times without rainfall. There are strong synergies between irrigation and other principal sources of agricultural growth such as fertilizer, improved plant varieties, better husbandry, upgraded infrastructure and better integration into markets. These encourage farmers to invest in land improvements and in other inputs.

Irrigation is difficult to analyze or to generalize about because irrigation systems are extremely diverse in terms of size, technological sophistication, crops produced, agronomic practices, economic and financial viability, reasons for existence, institutional organization and social context. However, their common denominator is that they all provide water to enable farmers to increase output per hectare.

In 1995/97, the total irrigated area in developing countries amounted to about 197 million ha (three-quarters of the world's irrigated area). Seventy-four percent of this irrigated land is in Asia, 14 percent in the Near East/Africa, 9 percent in Latin America and 3 percent in sub-Saharan Africa. In view of this and the fact that the annual growth of irrigated area in developed countries fell to 0.2 percent in 1990-1997, it is reasonable to conclude that events in developing countries will continue to dominate the world irrigation scene (FAO, 2000a).

Contribution

Irrigation increases cropping intensity and contributes to expansion in cropped areas. It increases yields, stabilizes output, enables crop diversification, reduces risk and increases farm incomes and employment. Through its influence on agricultural incomes, irrigation has a multiplier effect on non-farm incomes. It contributes to food security and poverty alleviation. By improving agricultural productivity, irrigation contributes significantly to overall growth and development (Box 1).

BOX 1
Agricultural productivity, growth and development

There is general agreement that increases in agricultural productivity are central to growth, income distribution, improved food security and poverty alleviation in rural economies. There is strong evidence that it is essential to accelerate agricultural growth if poverty is to decline rapidly.

Increased farm production improves farmers incomes, generates on-farm employment and lowers food prices, all of which reduce poverty as the poor typically spend 60-70 percent of their income on food. Recent studies suggest that an even more significant effect on rural poverty derives from increased farm incomes stimulating demand for the goods and services offered by the small-scale enterprise sector. Where labour is abundant, agricultural growth generates significant income and employment multipliers within the local non-farm economy. Where such large multipliers exist, technological change in agriculture has the potential to generate significant new non-farm earnings for the poor. Continued agricultural growth, and hence more water for irrigation, is essential if this subsector is to play its role in reducing poverty (Mellor, 2000; IFAD, 2001).

While determining the precise share of production gains attributable to irrigation is almost impossible, without the advances in irrigation technology and extraordinary investment in irrigation expansion by both public and private sectors, the Green Revolution would probably have had a much smaller impact (Barker and Van Hoppen, 1999). With the exception of the most favoured rainfed areas, the Green Revolution occurred only on irrigated land (Seckler, 1999).

The Green Revolution helped more than double the aggregate food supply in Asia over a 25-year period, with only a 4 percent increase in the net cropped area (Rosegrant and Hazzell, 1999). It also contributed to significant national

economic growth and saved large areas of forests, hillsides and other environmentally fragile lands from conversion to agriculture.

Perhaps the greatest benefit of irrigation has been in keeping food affordable to the poor. Between the 1960s and the 1990s real grain prices fell by approximately 50 percent as production growth continued to exceed population growth. Although subsidization of food grain production by developed countries played a part, the Green Revolution was largely responsible for this decline (Barker and Van Hoppen, 1999).

The Green Revolution also sustained employment (IFAD, 2001). Where an area doubled grain yields in the 1970s, employment per hectare normally rose by 40 percent, with a further 30 percent due to extra-farm demand for rural non-farm products (Hazzell and Haggeblade, 1993). The incidence of poverty in affected rural areas fell, typically from 30 to 50 percent to 5 to 15 percent (IFAD, 2001). In the 1970s agriculture accounted for 25 to 40 percent of GDP in the Green Revolution countries, which contributed substantially to their GDP and consumption growth.

In India, the multiplier effect of higher incomes in agriculture creating off-farm employment opportunities helped decrease the number of people below the poverty line from 50 percent to approximately 35 percent between the mid-1970s and 1990 (Datt, 1998).

Irrigation has good distributional effects as most irrigation projects have targeted private farmers (mostly smallholders) and its benefits accrue mainly in rural areas. Two-thirds of the income of the rural poor comes from farming and most of the rest depends for growth on linkages to farming (IFAD, 2001).

In developing countries irrigation serves about one-fifth of all arable land, accounts for some 40 percent of all crop production and almost 60 percent of cereal production. Recent analyses suggest irrigated agriculture will account for 38 percent of the total increase in arable land and for more than 70 percent of the increase in cereal production between 1995/1997 and 2030 (FAO, 2000a).

Expansion

Between 1961/1963 and 1995/1997 the irrigated area in developing countries increased at an annual rate of 1.9 percent to 197 million ha. Asia registered the largest increase: 70 million ha (mainly in India, Pakistan and China); while in sub-Saharan Africa the increase was 2 million ha. The prediction is for the area of irrigated land to increase by 0.6 percent per year to 242 million ha in 2030. Declining and insufficient investment in agriculture, the broader water sector and irrigation reflects this decrease in irrigation expansion.

In developing countries there are signs of underinvestment and underperformance in agriculture. When measured in constant 1995 prices, official development assistance from bilateral and multilateral donors is 8 percent below 1990 levels. Throughout the 1990s the flow of funds to primary agriculture declined while there was increasing attention on other areas, in particular environmental protection, rural development and infrastructure (FAO, 2000b). The proportion of sectorally allocable aid reaching agriculture, forestry and fisheries fell to 20 percent in 1987-1989 and then to 12.5 percent in 1996-1998. The real nature of net aid disbursed to agriculture in the late 1990s was 35 percent of its level in the late 1980s (IFAD, 2001). In financial year 2000, World Bank lending for agriculture and rural development was its lowest ever in both percentage terms and absolute amounts (World Bank, 2000).

Estimates of current annual investment in the water sector range from approximately US$60-80 billion (DFID, 2000; Elz, 2000; World Bank, 2001). Of this amount approximately 90 percent comes from domestic resources and the rest from international donor aid and multilateral

funders, of which the World Bank is the principal source (DFID, 2000; World Bank 2001). The World Commission on Water considers investment levels to be less than half of that needed (about US$180 million per year) to meet minimum water, sanitation and nutrition requirements, mostly in developing countries, by 2025. On a global level there is a substantial shortfall, both for capital investment and for the operation and maintenance (O&M) of existing infrastructure. The tendency is to allocate most money to new capital works with insufficient funding for operation, maintenance and system rehabilitation. Recent studies indicate that the amounts allocated for irrigation scheme O&M are typically less than 50 percent of those required (DFID, 2000).

From 1950 to 1993, 7 percent of World Bank lending went to irrigation, more than any other subsector (Jones, 1995), but fell to about 4 percent for the period 1990-1997 (DFID, 2000).

This decline in investment in agriculture and irrigation does not augur well for the anticipated increase in irrigated land between 1995/1997 and 2030.

Paradox

The decline in investment in new irrigation projects is leading to a paradoxical situation where although meeting the increasing demand for food will require more irrigated land, the investments may not be forthcoming. Given the long lead time between planning and implementing irrigation projects, failure to reverse the downward trend in investments could soon lead to food shortages with direct consequences for many developing countries and particularly for the poor.

One way of starting to resolve this paradox is to examine the reasons and related circumstances for the reduced investments in irrigation and to put the factors involved into perspective within the challenges facing the agricultural and food sectors in developing countries.

LAND IMPROVEMENT IN LESS-FAVOURED RAINFED AREAS

Agricultural development strategies emphasizing irrigated agriculture have increased food production and stimulated economic growth. At the same time large areas of less-favoured rainfed lands suffer from neglect and lag behind in their economic development. These lands are characterised by low agricultural potential, often because of poor soils, steep slopes, short growing seasons and lower and uncertain rainfall, but also because neglect has left them with limited infrastructure, weak institutions and poor access to markets. As population densities grow with no matching increases in production, food insecurity and poverty worsen and widespread degradation of soil and water resources tends to occur.

On development and environmental grounds alone, there will need to be a greater focus on less-favoured areas in setting priorities for policy and public investments. In some cases land expansion can contribute to increased agricultural production. However, in many less-favoured areas, social and environmental crises are already common sometimes soliciting more investment in crisis relief than in development from governments and donors. There is evidence that strategic investments in the economic development of less-favoured areas can be more cost effective than relief even in a relatively short period of time (Owens and Hoddinott, 1998). Increased public investment in technology and infrastructure in less-favoured areas may yield higher marginal returns than comparable additional investments in irrigated agriculture (Fan and Hazzell, 1997).

This does not mean that there should be less public investment in irrigated and high-potential rainfed areas in developing countries. It signifies that there should be a better investment balance between irrigated and less-favoured areas because reclamation and/or further development of the latter

can benefit the large numbers of poor people living there. The amount of economically justifiable public investment in any locality should depend on the net social returns from productivity growth, poverty reduction and the containment of environmental degradation.

The investment needs of less-favoured rural areas often involve improving health and education, infrastructure and agricultural production in different combinations and in an integrated manner. Farming systems in less-favoured areas typically include mixed farming and other practices that contribute to soil, nutrient and water conservation. Thus, while some types of commodity improvement are relevant for less-favoured areas there is growing consensus that major productivity improvements will have to come from improved natural resource management practices and technologies tailored to the ecological, social and economic circumstances of rural communities, e.g. conservation tillage and integrated watershed development.

BOX 2
Land improvement in Santa Catarina state, Brazil

From 1991 to 1999 the World Bank provided a loan of US$33 million to Santa Catarina state to reverse ongoing land degradation and to increase agricultural production, productivity and farm incomes for 81 000 mostly small-scale farmers in 520 of its 1 700 microcatchments.

The main thrust of the project was to introduce and develop conservation tillage. Accompanying elements were: the upgrading of extension and training adaptive research, control of erosion runoff from rural roads and an incentive programme to encourage the adoption of conservation practices.

Production of the main crops – maize, wheat and soybeans – increased by an estimated 20 to 35 percent. Farmers adopted improved land management practices including conservation tillage on some 400 000 ha in 434 assisted microcatchments. The project reached about 35 percent of the state's farmers and reduced soil loss by 10 to 50 percent. Runoff water in streams contained fewer suspended solids, coliform bacteria and pesticide residues thus reducing silting and water treatment costs and lowering the incidence of water-borne diseases and pesticide poisoning.

The project's estimated rate of return at appraisal was 20 percent.

Land improvement techniques

Conservation or minimum/zero tillage is a practice that replaces conventional ploughing with adapted planting equipment and appropriate crop rotation. By protecting soils from erosion, improving soil structure, raising soil fertility, increasing water retention on cropland and reducing land preparation costs, conservation tillage helps increase yields and profitability.

Following its successful application in the central and southern parts of Brazil (Box 2), parts of Paraguay adopted conservation tillage to counter widespread soil degradation and erosion. As the result of an almost threefold increase in net farm income and average rates of return on marginal investment in equipment of from 6 percent (medium farms) to 14 percent (large farms), conservation tillage spread to 250 000 ha (19 percent of land cultivated mechanically) between the late 1970s and 1995/1996 (Sorrensen, 1997).

Various forms of land reclamation and development by means of manually and mechanically induced soil and water conservation have also proved successful. For example, in low rainfall areas of Senegal and Burkina Faso widely spaced small shallow basins, or furrow lines created with tractor drawn equipment captured sufficient runoff to establish islands or strips of tree and shrub species. This in turn led to more widespread improvement in soil physical characteristics and increased fodder production. Livestock carrying capacity improved and in some areas better soil moisture regimes nearly doubled the yields of millet and niébé (Dutraux and Keita, 1999). In another project in Burkina Faso and Niger a combination of small stone bunds and hand-dug holes filled with manure helped treble millet and sorghum yields and restore about 100 000 ha. Food availability in participating households rose by 20-40 percent. The average family using these technologies moved from an annual cereal deficit of 644 kg to a surplus of 153 kg (IFAD, 2001).

INTEGRATED WATERSHED DEVELOPMENT

Because of the interrelationships between ecological, social and economic factors that cause soil and water degradation and because of the need to include these factors when reclaiming and improving land and water, integrated watershed development has become the preferred approach for developing rainfed areas in many countries. In general such projects have two major objectives:

- conservation – to slow and reverse the degradation of the natural environment in project areas through the development and use of appropriate soil and moisture conservation measures;
- development – to promote systems for the production of food, fodder, forest and livestock products that improve beneficiaries' incomes and well-being on a sustainable basis.

Typically, the largest component of such projects comprises physical investments in soil and water conservation technologies and practices, which provide the basis for improved agricultural productivity. The second largest element is to establish and/or strengthen institutional arrangements and the human skills needed to ensure the implementation and sustainability of projects. Watersheds or subwatersheds have proved to be practical units for the implementation of this type of project. Such projects usually achieve their conservation and production objectives. The key aspect is the institutional and financial sustainability of these and future investments. Experience points to a number of basic determinants for success in this regard. These include: the importance of ownership of the project by beneficiaries; the need for beneficiaries to realize some short-term benefits from project interventions; the need to provide integrated support services; and the importance of monitoring and feedback mechanisms to periodically evaluate progress and make any necessary corrections.

Three World Bank-funded integrated watershed development projects (representing some US$133 million in loans) implemented in India and Indonesia during the 1980s yielded economic rates of return at completion of 17, 14 and 13 percent respectively. These conservative calculations consider only quantifiable benefits such as increased crop yields and do not include non-quantified benefits such as reduced erosion, siltation and pollution.

This indicates that agricultural intensification mainly through land and water development should be a key component of development strategies in less-favoured rainfed areas in certain countries. Such investments can yield acceptable economic rates of return with direct benefits for participants. Where the evaluation takes their social and environmental impacts fully into account their returns may exceed those of other agricultural investments. Nevertheless, because the shortage of water limits the production potential of most less-favoured areas, their contribution to overall food grain production and food security in most countries will remain relatively modest. High-potential areas with irrigation will continue to be the breadbaskets for most developing countries.

IMPACTS AND BENEFITS OF INVESTMENT IN LAND AND WATER

Investment in developing land and water resource offers long-term benefits that may elude quantification by conventional analysis. Beyond a project's immediate rate of return, developing countries need to consider the wider benefits in terms of increased domestic production, enhanced food security, reduced market fluctuations, and foreign exchange savings. Moreover, such investments involve many interrelated factors with a range of potential direct and indirect effects. Although it may not be possible to legislate for successful investment, countries can pursue policies that are conducive to creating the conditions for greater market efficiency and higher farm-gate prices.

As the preceding chapter provides an indication of the returns and long-term benefits from investing in land development projects, the following sections concentrate on the impacts and benefits of investment in irrigation.

Returns on investment

Returns on investment in irrigation are comparable to alternative investments (Carruthers, 1996). The most comprehensive evaluation of irrigation project performance is the World Bank study of 208 World Bank funded irrigation projects implemented and evaluated between 1950 and 1993. It also examined a further 614 projects with irrigation components, more than 100 irrigation projects at various stages of implementation and non-World Bank studies that enriched the exercise. World Bank lending for irrigation during the period was US$31 billion (Jones, 1995).

Of 192 projects subjected to both appraisal and evaluation, 67 percent rated satisfactory and their average estimated economic internal rate of return (IRR) at evaluation was 15 percent. After allowing for inflation, this level of return is impressive especially as most projects require large initial investments and have a long gestation period before net benefits materialize. The comparable satisfactory rates for agriculture as a whole and the all-project average are 65 and 76 percent respectively. The IRR for agriculture as a whole is 13 percent and the all-project average is 16 percent. Weighting irrigation projects by size of area served raises their average IRR to 25 percent with 84 percent of the projects rating satisfactory.

These overall ratings are surprisingly good as typical irrigation projects are extremely complex. They involve engineering, agronomic, sociological and organizational changes that render implementation and sustainability difficult. A positive element is that irrigation projects have quantifiable objectives which facilitate establishing their degree of success or failure by measuring them against no-project situations. In addition, the projects achieved their average evaluation IRR of 15 percent in an era when overvalued exchange rates and a variety of indirect taxes or subsidies to competing urban interests penalized agriculture (Carruthers, 1996).

Implementation Completion Reports on 11 World Bank financed irrigation projects in Asia and Latin America (mainly in the 1990s) for a total loan amount of approximately US$1.973 billion had an average economic rate of return at completion of 17 percent.

A strong indication that irrigation pays is the amount of private investment it attracts. Private investment provides all the financing for about 20 percent of the total area currently irrigated (about 264 million ha in 1995/97). The share of private investment in the remaining 80 percent is approximately half of the total investment. Furthermore, there is an estimated additional 70 million ha of land under informal private irrigation that falls outside government control.

This information indicates that it would not be rational to avoid investing in irrigation projects on the grounds of low investment returns.

ENVIRONMENTAL AND SOCIAL IMPACTS

Irrigation often has negative environmental impacts such as waterlogging and associated salinization of soils due to overirrigation and inadequate drainage. Overextraction of groundwater is also widespread in many developing countries. In some areas, particularly in the Near East/North Africa, irrigation draws on fossil aquifers that receive little or no recharge and is therefore not sustainable. The environmental and economic consequences of such practices are serious and will grow worse in the absence of appropriate responses (FAO, 2000a).

Because of its role in agricultural intensification, irrigation contributes to the pollution of surface and groundwater with nitrates, phosphates and ammonium compounds. The latter can cause excessive algal growth, proliferation of aquatic weeds and eutrophication in irrigation canals and downstream waterways thereby damaging fragile ecosystems. Irrigation can contribute to the increased incidence of water-borne and water-related diseases, and to problems associated with the resettlement of displaced people.

However, irrigation also has very important and pervasive positive environmental impacts. For example, the high population absorptive capacity of irrigation limits the migration of growing populations to areas of greater environmental risk. If additional water for irrigation (17 percent by 2025) is not forthcoming, the increased burden on rainfed agriculture to meet demand will be enormous and detrimental to the environment, with far more land clearance than is currently the case (Elz, 2000).

Furthermore, there are technical, economic and social solutions for most of the negative effects of irrigation (Carruthers, 1996; FAO, 2000a). For example, there is major potential for meeting future agricultural and overall water needs by raising water use efficiency, thereby reducing environmental damage in many cases. It is possible to repair much of the damage already done and avoid similar problems in the future. Many of these solutions are likely to require a management rather than an investment approach.

Irrigation is a factor in global environmental issues such as climate change as irrigated rice production contributes about 20 percent of global methane emissions. This is causing increasing concern as methane is 20 times more powerful than carbon dioxide and atmospheric levels are rising fast. However, even with a projected expansion in the area under rice of about 6.5 percent by 2030, methane emissions could decrease as farmers grow more low-methane rice under controlled irrigation with better nutrient management (FAO, 2000a).

In addition, the potential exists to transform cultivated land from a net source to a major net sink of carbon. Any practice which improves plant cover and yields such as irrigation contributes to this process.

The fact that irrigation is facing a number of challenges is not a reason for withdrawing from it but rather a reason for engaging in a search for solutions (Carruthers, 1996).

Scheme size

Little has damaged the image of irrigation as much as the negative impacts (land inundation, population displacement and ecological disruption) of large irrigation schemes, especially those with large dams. However, any balanced assessment should also include their positive effects (Seckler, 1998). Moreover, much irrigation does not involve large dams, whose prime function tends to be more for electricity generation and flood control rather than for irrigation.

In many developing countries large-scale irrigation schemes remain essential for food production, employment generation and development (Elz, 2000; Gleick, 2000; IFAD, 2001; Seckler e*t al.*, 1998). The World Commission on Dams is evaluating dam projects using an objective approach to incorporate more accurate estimates of their true costs and benefits (Gleick, 2000; IFAD, 2001).

Box 3
Efficiency of water use

The concept of efficient water use in irrigation includes the conveyance efficiency, field efficiency, water use efficiency and economic efficiency of water (water productivity) amongst others. There is a tendency to consider water use and allocation in a holistic manner because of the highly integrated nature of water use systems involving different users. This entails establishing the water balance of river basins. This may require analyzing systems' efficiency at different levels. Thus, measuring water use efficiency can be complex and the high degree of external effects may make it more difficult.

The evaluation of World Bank financed irrigation projects shows a strong correlation between project size and satisfactory performance: the larger the command area, the higher the likely economic returns. This is true for surface and groundwater projects and applies to all regions. The economies of scale stem from engineering and management efficiencies (Jones, 1995).

However, small-scale schemes do have definite advantages under particular circumstances. Because of their limited more cohesive membership and simple institutional arrangements, such member-controlled schemes generally enjoy more efficient and flexible distribution and maintenance regimes. However, their limitations often include: no outside agency to bear risk; lack of financial or borrowing capacity; uneconomic irrigation design and management. Another problem is that negotiations with other upstream and downstream users to maintain equity of water use within watersheds or aquifers can be difficult (IFAD, 2001).

Water use efficiency

Irrigation accounts for 80 percent of freshwater withdrawals in developing countries. One way for such countries to expand their irrigation is by improving water use efficiency.

While the concept of efficient water use is complex (Box 3) and difficult to achieve in practice, improving the efficiency of irrigation water use can contribute significantly to meeting growing demands. Seckler (1998) estimates that the amount of water saved by achieving an irrigation effectiveness of 70 percent in total gross irrigated area by 2025 could meet about one-half of the increased demand for additional water supplies in the 1990-2025 period. However, the conceptual and practical challenges to achieving such efficient water use are equally large because water has multiple users, uses and externalities. Better irrigation scheme organization and management and the rehabilitation and upgrading of existing schemes are generating real gains.

FAO (2000a) estimates the irrigation efficiency of a group of 93 developing countries to range from 26 percent in areas of abundant water (Latin America) to 50 percent in the Near East/North Africa region where water use calls for higher efficiencies. The forecast is for irrigation efficiency for these countries as a group to rise from 43 percent in 1995/7 to 50 percent by 2030.

Notwithstanding wide variations between regions and countries in the group, water withdrawal for irrigation accounted for about 7 percent of total water resources in 1995/1997. The forecast is for water withdrawal to grow by 12 percent by 2030. Thus, there is sufficient water for future irrigation and other needs in these countries. Nevertheless, in most countries where irrigated agriculture is already important, water for expansion will have to come mainly from efficiency savings on existing schemes. Given the need to boost agricultural productivity and growth in these countries, the importance of investing in water saving technologies and practices is clear.

Rehabilitation and upgrading

Given the need to use irrigation water more efficiently on existing schemes, it follows that the bulk of new investment should focus on rehabilitation and upgrading rather than on new schemes. Indeed, it is now often difficult to distinguish between new development and the extension of existing schemes. Projects are usually a combination of the above aspects. This is of little consequence providing that investments are economically viable and enhance scheme functioning and sustainability. However, it is important to avoid misconstruing rehabilitation for deferred maintenance without correcting the problems causing unsustainable maintenance in the first place. If not, this could lead to repetitive funding of maintenance from external sources.

In order to maximize returns, scheme improvement should incorporate lessons from previous irrigation developments and not simply rehabilitate projects to old standards. Improving performance includes repairing and modifying structures and enhancing scheme management and associated institutional arrangements.

Good planning and implementation are prerequisites for high investment returns. This is particularly relevant for complex, multi-dimensional irrigation schemes usually involving a number of interested parties. It is counterproductive to skimp on resources needed for the preparation, appraisal and implementation of such projects. Unforeseen problems that arise during implementation should be resolved promptly even at the expense of extending implementation. Confirmation comes from the evaluation of World Bank irrigation projects which showed that variations in implementation time (whether overall time or delay) had no effect on economic returns (Jones, 1995).

The emphasis on rehabilitation and upgrading can contribute to improving returns on new investments in irrigation in a number of ways. First, efficiency gains do not only make water available for new irrigation. By reducing overirrigation, they also attenuate the principal causes of land degradation on irrigation schemes, such as waterlogging and salinization. This is important as waterlogging and salinization significantly reduce irrigation performance in some countries. Second, because a considerable part of the extensive investments in irrigation during past decades are now regarded as sunk costs, incremental investment in improving scheme performance will yield high rates of return. Confirmation of this comes from the competitive economic rates of return obtained with irrigation projects that include a substantial portion of rehabilitation. Third, increased productivity and growth resulting from improving schemes will reduce the urgency to develop new irrigation to meet growing food needs. This will provide more time to thoroughly appraise and plan new irrigation development that will become economically less attractive if development costs increase and the prices of agricultural commodities stagnate or decrease. It will also allow more time to incorporate lessons from existing projects into new development.

Another advantage of rehabilitation is that project unit costs are usually low, a fact which increases the likelihood of economic viability (Jones, 1995).

The need to fund rehabilitation from external sources reflects low economic returns from first generation projects. At the same time the large volumes of sunk costs in these schemes offers the opportunity to place them on a sound economic, social and environmental footing while assuring rates of return comparable to other investments.

Operation and management

Inadequate operation and management of irrigation schemes is often a major cause of poor project performance and weak sustainability. Many governments have found it increasingly difficult to finance the costs of irrigation operation and management as well as being effective providers of water services to large numbers of small farmers. These factors have led to infrastructure deterioration, shrinkage of area irrigated, maldistribution and wastage of water, and advancing waterlogging and salinity.

Many governments are attempting to transfer management responsibility for irrigation systems from government agencies to farmers organized into water users associations (WUAS) (IWMI, 2000). Consensus is emerging that operation and management problems, scheme maintenance, irrigators' ownership of their systems and cost recovery are interrelated. Evidence is accumulating that comprehensive yet pragmatic approaches that include the above aspects can overcome organization and management problems.

The keys to these unusually complex, interrelated problems reside in the principles of financial autonomy and irrigator participation in organization and management by means of viable WUAs. The most promising route to improvement lies in making irrigators responsible for their own organization and management and in providing them with the requisite technical support particularly regarding group formation and the skills needed for effective scheme management. There is a considerable amount of experience about the circumstances that encourage irrigators to create effective and durable groups (Ostrom, 1994, 1996). One clear lesson seems to be the importance of recognizing that group members have to bear costs as well as receive benefits.

One of the prerequisites of such an approach is government willingness to devolve. Global experience suggests that irrigation management transfer on a large scale has been most successful where: the irrigation system is central to a dynamic, wealth-creating agriculture; the average farm size is large enough for a typical or a significant proportion of the command area farmers to operate like agribusinessmen; backward linkages with input supply systems and forward linkages with output marketing systems are strong and well-developed; and the costs of self-managed irrigation are an insignificant part of the gross value farming output (IWMI, 2000). Mexico provides a successful example of irrigation management transfer (Box 4).

BOX 4

Reform and irrigation management transfer in Mexico

Following a sharp decline both in public investment in irrigation and also in farmers' contributions to organization and management costs, and with irrigated crop production falling 0.4 percent per year, the Government of Mexico took decisive action. It opted to transform irrigation from an engineering driven, centrally managed and government funded sector to a more decentralized system based on transparent investment selection criteria and greater participation of beneficiaries in decision making and cost recovery. Moreover, it reduced agricultural price support to market related levels.

The outcome has been that water users have increased their funding of organization and management from 20 to 90 percent, organization and management costs have fallen about 40 percent, and water use efficiency and productivity is improving by about 3 percent per year. Government financial contributions to organization and management have almost disappeared. Due to increased water-fee collection and improved management, rehabilitation, deferred maintenance and upgrading are ahead of schedule. Water table problems, salinity and other unfavourable environmental effects are diminishing. Land values in rehabilitated saline areas have increased fourfold. Because of improvements in production efficiency and productivity and the elimination of price guarantees, the value of agricultural production is growing at 4.8 percent per year. Rising agricultural exports have had a favourable impact on terms of trade.

The estimated overall economic rate of return for the project at completion is 31.5 percent over 20 years.

Two important determinants of success for the project have been strong political support for the process and appropriate accompanying macroeconomic and agricultural policy reforms.

An important principle underlying the privatization of irrigation schemes is using water as an economic good. While water is an economic good in most cases, Perry *et al.* (1997) ask "whether it is a purely private good that can reasonably be left to free market forces, or a public good that requires some amount of extra-market management to effectively and efficiently serve social objectives". The answer to this lies in value judgements and their application to different conditions of time and place. While privatizing water in the sense of giving farmers and markets a greater role in both financing and management of irrigation may be promising, it is also necessary to satisfy basic needs criteria before optimizing economic returns in terms of consumers' sovereignty. Perry proposes sequential preconditions for the beneficial introduction of market forces in water allocation and use.

Privatization of minor irrigation in Bangladesh illustrates how policy liberalization accompanied by technical support can promote increased smallholder investment in irrigation and thereby boost agricultural production, farm incomes and employment (Box 5).

Box 5
Enhanced agricultural growth through increased private sector investment in minor irrigation in Bangladesh

Implemented between 1991 and 1997, this project achieved its primary objective of faster growth in agriculture through increased private sector investment in minor irrigation by eliminating regulations, subsidies and other advantages which favoured public sector provision of minor irrigation based on deep tubewells and pumped surface water irrigation.

The project facilitated the provision of equipment by agents and provided technical assistance for training and for strengthening support institutions. It also provided assistance for a range of project support services including: planning and implementation of minor irrigation, formation of WUAs, selection of equipment, assessment of irrigation growth, hydrological exploration, and trials for irrigation technologies and rehabilitation methods.

In the six-year period, the number of shallow tubewells (STW) and the STW irrigation area increased at annual rates of 32 and 16 percent respectively. Liberalization of the sector led to: an increase in the number of equipment suppliers and equipment servicing facilities (rural workshops); a reduction in engine and other equipment prices; and an increase in the number of farmers owning tubewells. The latter included a growing number of small farmers who gained access to irrigation benefits, thereby positively influencing the equity impact of the project. Annual farm income rose by 25 and 53 percent for STWs and deep tubewells respectively. The project's estimated economic rate of return at completion was 16 percent.

The project successfully supported government in making important policy changes to liberalize the minor irrigation sector that promoted rapid development in minor irrigation and in services catering to this technology. The overall evaluation was that the project had significant positive effects on the economy of Bangladesh.

Gradual, selective privatization of organization and management and other aspects of irrigation shows considerable promise as a way of improving scheme viability and sustainability. Investment in privatization measures have produced encouraging results.

CONCLUSIONS

In the coming decades irrigation will become increasingly important as it will enable intensification to generate 80 percent of overall growth in crop production and 70 percent in cereal production. While important, rainfed agriculture lacks potential to replace irrigated agriculture in any significant way. Thus, irrigation is vital to developing countries' attempts to achieve food security and meet other growing needs and, as a whole, they do have sufficient land and water for its anticipated expansion.

Through its impact on agricultural productivity, irrigation has be neficial effects on rural incomes, rural employment, food security, poverty alleviation and overall growth and development. Moreover, it has had a significant effect in keep food affordable to the poor. Without more irrigation many countries will not attain the agricultural and overall economic growth rates required to achieve food security and reduce poverty. Irrigation also has positive

distributional effects because it mainly targets smallholders living in poor rural areas.

The financial returns on investments in irrigation are generally comparable to alternative investments. Indeed, most analyses may understate their true returns by failing to consider all the positive indirect social and environmental effects of irrigation. Future investments in irrigation will be mainly for rehabilitation and upgrading and will earn higher rates of return by benefiting from the large amount of sunk costs in existing schemes. Viewed differently, a failure to maintain and improve existing schemes would result in the loss of the benefits of the investment already made in irrigation. The large amount of private investment that irrigation attracts worldwide indicates that it does yield worthwhile returns.

Technical, economic, social and environmental solutions now exist to rectify and prevent most of the problems associated with irrigation. By adhering to sound guidelines, irrigation projects can be an environmental asset. Thus, it would be a mistake to allow a perceived negative image to constrain investment in irrigation.

Improvements in the current low level of water use efficiency in irrigation will release large volumes for expansion, and for use by other sectors. There has been considerable progress in using technological, operational and managerial methods to improve efficiency levels. The underlying principles at work are those of irrigator participation, financial autonomy, partial and progressive privatization and corresponding government withdrawal. Their practical application will enhance the viability of future investments in both existing schemes and in developing new ones.

In addition to investment in irrigation, there is also a need for more investment to reclaim, conserve and further develop the productivity of land and rainfed agriculture in less-favoured areas. Techniques such as conservation tillage and integrated watershed development have demonstrated that investment in these areas can yield acceptable returns while achieving the twin goals of productivity growth and poverty alleviation. Marginal returns to such investment in less-favoured areas can exceed those in irrigation. A proper balance between the two will help to develop the potential of less-favoured areas and satisfy the needs of the people living there.

Investing in a land or water development project is not just an investment in one item, it entails investing in a whole range of elements such as farming practices, plant varieties and nutrients, human resources, the broader infrastructure and conducive policies.

The international community is committed to development goals with pressing humanitarian implications. However, in order to enable the vital elements of land and water to make their full contribution to achieving these goals, it is necessary to increase their productivity. This will not happen without increased investment in land and water development.

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Agricultural investment strategies: prioritizing land and water

INTRODUCTION

This paper uses FAO and related studies to bring out the critical role of land and water investments in any broad based growth strategy for the developing countries of Asia and the Pacific region. Land and water investments are under field conditions, integrated with each other. As land reserves are used up, water investments and policies become the key to overcoming the land constraint and sourcing agricultural growth for food security and development. This is particularly so in the post-WTO scenario. Improved and more timely water supplies in the field are also associated with the introduction and spread of the new technologies, at the initial phase of even bio-technology varieties.

The water sector was neglected in the last decade of the last century, despite FAO's studied interventions to the contrary. More recently, the link between sustainable rural growth and a multi-pronged land and water development strategy under alternative agro-climatic regimes in Asia and the Pacific region has been established in a fairly systematic manner. Successful newer paradigms of development include multi-financing sources, taking account of private, community and borrowed resources and newer forms of organizations, including private, cooperative, NGO-led and community organizations and 'mixed' forms. Research, however, shows the need for the state to play a major strategic and enabling role, setting up new institutional organizations, establishing financial and organizational rules and creating a framework for resolving problems that inevitably arise with innovative solutions. We illustrate some of these issues with data and carefully selected examples and best practice case studies.

STRATEGIC ROLE OF LAND AND WATER INVESTMENT

FAO moved from irrigation as an agricultural input to a perception of the synergistic role of water in the process of agricultural growth as early as the late-1970s in *Agriculture Towards 2000*: "The pervasiveness of such influences is suggested by a comparison of targets for 1975 proposed in the 1969 FAO Indicative World Plan for Agricultural Development (IWP) with actual experience up to 1976. While actual production growth in most developing regions was below proposed growth rates, most identified inputs ... actually exceeded growth rates proposed for them".

For example, the targeted annual growth rate for agriculture in Asia and the Pacific was 3.7 percent, but the achieved rate was 2.6 percent. However, arable land grew at 0.6 percent annually,

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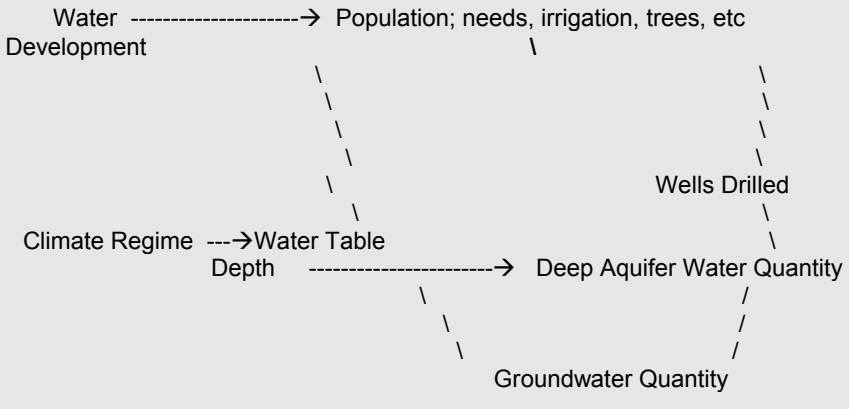
twice the target rate and irrigated land at 2.2 percent while the target was 1.8 percent. Since then policy and planning exercises have been more holistic with simultaneous development of land and water. Thus the planning methodologies of *Agriculture Towards 2000* considered the development sequence of moving land from a soil and water regime to an alternate one. There were five land and water classes of numerical models, from bad soils with low and variable water availability to good irrigated lands. This more synergistic view was developed from FAO field experience in preparing agro-climatic regimes for appropriate cropping and farming systems. *Agriculture Towards 2010* carried this process to a logical conclusion with sustainable development of land and water resources providing the basis of farming systems (Alexandratos, 1995).

These integrated views had an impact on policy recommendations and target systems. In some countries the role of irrigation in releasing the land constraint was clearly seen. One planning exercise for Asia stated that: (i) harvested area could be estimated directly as a function of past irrigated area, giving a direct estimate of elasticity of harvested area to harvested irrigated area; (ii) cropping intensity could be estimated as a relation of arable irrigated area; and that (iii) cropping intensity could be separately estimated for irrigated and non-irrigated areas and time trends analyzed and projected.

These categories are approximate and water is now treated in a more sophisticated framework which connects scarce resources with sustainable food and water security. Water flows do not follow administrative or political boundaries; geophysical and not political and administrative features confine aquifers. Climate also determines the demand for water, including evaporation. Seasonal rainfall cycles can be very different across countries. For structural understanding and policy analysis, water is now seen as central to a sustainability agenda.

Water availability is now more accurately estimated in structural analysis and advanced project design for aquifer management, drainage and conjunctive use projects, e.g. the Mike She model for Australia's Murray Darling Basin Plan used by the New South Wales Department of Land and Water Conservation. As discussed by Millington (1996) it is used for integrated catchment modelling and its main features can represent major flow features and describe dynamic interaction between surface and subsurface water systems. A simple multi level flow chart model is shown in Figure 1.

Figure 1



Source: Nicholas Sonntag (1996)

A more detailed version with added water resources made available by more precise basin assessment is seen in the Mahi Narmada Doab model developed by Alagh and Buch with initial heads

in 1980, calibrated heads for 1990 and forecasts for 2000 under alternative use assumptions. The model reflects forest cover, surface irrigation and pumps drilled (Fisher, 1995).

Integrating surface flows with local small storage projects is now more accurate. A 14 percent rise was reported in estimated water availability – not trivial in the context of water scarcity – in the Shedhi branch of the Mahi system, initially planned with no tanks (Table 1)

TABLE 1
Tank storage in the Shedhi system

Year	Number of tanks deepened (progressive)	New capacity created (million m3)	Range of deepening (m)
1993/1994	**150**	**3.5 (6.0 to 9.9)**	**1 to 6**
June	**254**	**6.0 (7.9 to 13.9)**	**0.25 to 9.3**

Source: Alagh (2000)

Microstudy approaches to water resources availability assessment reflect complex sources compared to earlier assessments based on empirical formulas, preliminary projections and simple guesses. International programmes address such limitations, but there is a more basic problem. The synergy of water as a sustainable holistic resource can only be captured with integrated methodology, e.g. simultaneous use of tanks and surface conveyance strategies. More precise assessments can be of critical importance.

TABLE 2
Irrigated area: share and growth, 1967 to 1995 (growth rates on 3-year moving averages)

Country	Share of Agricultural Area Irrigated %		Growth of Irrigated Area % annual	
	1970	1995	1967/1982	1982/1995
Bangladesh	11.63	37.56	4.95	5.39
China	37.18	37.02	1.59	0.79
India	18.44	31.82	2.64	2.42
Indonesia	15.00	15.18	0.65	0.49
Korea Republic	51.52	60.76	0.73	-0.65
Malaysia	5.91	4.47	2.34	0.22
Myanmar	8.04	15.38	1.87	3.37
Nepal	5.91	29.82	12.55	2.67
Pakistan	66.99	79.63	1.39	0.89
Philippines	11.88	16.60	3.80	1.33
Sri Lanka	24.55	29.16	1.91	0.21
Thailand	14.19	22.70	4.23	2.78
Viet Nam	15.95	29.60	3.71	1.29
Total	25.17	33.24	2.05	1.56

SOURCE: FAOSTAT

Conceptually, water availability measurement is in the context of physical systems in the ecological domain. This is a strong argument for integrating such work with the FAO tradition of cooperative work with UNESCO on agro-economic zoning, including soil and land categories: dry semi-arid, moist semi-arid, subhumid and fluvisols/gleysols and marginal variations of these, plus irrigated desert (FAO, 1978/81; FAO, 1982; FAO, 1993).

Agro-economic zoning of soil/land type, water and climate by category is of central importance. Climate here means weather, i.e. temperature and rainfall levels and variations, while water is both surface and ground. The concept is well described in Sadasyuk and Sengupta (1968) who divided India into 18 agro-climatic zones and 44 subregions. Similar exercises have been developed in other large countries such as Indonesia (Nasution, 1993).

SLACKENING INVESTMENT AND STRATEGIC RESPONSES

That real investment in land and water has not progressed as suggested by the FAO Global Models, Policy Studies and Global Conferences is well known. Moreover, there is evidence that efforts and investment have fallen since the 1980s compared to earlier periods. Table 2 shows that from 1982 to 1995 growth of irrigated area was 1.56 percent annually in 13 Asian countries, compared to 2.05 percent annually from 1967 to 1982. Irrigation growth declined in 11 of 13 countries, the only exceptions being Bangladesh and Myanmar.

Countries where irrigation growth declined by 50 percent or more from 1982 to 1995 compared to 1967 to 1982 were China, Republic of Korea, Malaysia, Nepal, Philippines, Sri Lanka and Viet Nam. Given the primal role of water in a synergistic policy of widespread rural growth, these developments are of concern.

TABLE 3
Poverty removal and malnutrition amelioration based on water development Asia 2020

REGION	Per capita food availability (kcal/day)					Rural poverty (millions)		Eliminating malnutrition (malnourished children, 0-5 years, millions)		
	1970	1993	2010			2020	1970	1993	2010	
			A	B	C				D	E
India	2 083	2 397	2 559	2 764	3 201	213	250	76	59	31
South Asia	2 184	2 370	2 510	2 719	3 201	72	64	100	83	41
China	2 019	2 680	2 913	2 913	3 535	364	266	24	17	0.4
Southeast Asia	1 945	2 525	2 626	2 626	3 193	74	90	16	13	4
Developing Asia	2 045	2 525	2 646	2 646	3 275	722	669	140	113	45

NOTE: A = Low Investment: Weak Reform; B = High Investment: Strong Reform; C = Eliminating Malnutrition; D = Baseline; E = Elimination.
Source: ADB, 2000 based on IFPRI data.

The need to reverse these trends is obvious. Practical steps to emphasize the need for land and water investment are necessary, such as educational campaigns with content as indicated above. These would rely on the synergy and sustainability of land and water investments. NGOs, farmers' groups, agricultural universities, schools and the media could be involved in a long term process.

As many people are more impressed by disaster predictions than by basic education an effective strategy might emphasize crisis aspects of neglect scenarios relative to water and food security as 'New Millennium' variants of earlier FAO Self-Sufficiency Ratio (SSR) indicators.

A useful way to respond to the neglect of policy and investment in land and water development is to press for an understanding of scenarios of widespread sustainable growth, food security and water security using available rural development scenarios. *Agriculture Towards 2010* projections need not be repeated. Recently the Asian Development Bank (ADB) used International Food Policy Institute (IFPRI) studies to project such scenarios. Table 3 reflects the critical role of land and water development policies on eliminating poverty and malnutrition.

Rural poverty is very high in Asia and the Pacific region (669 million in the 1990s), with 266 million poor in China and 250 million poor in India, according to IFPRI studies used by ADB. IFPRI's global IMPACT model projects a 'business as usual' scenario of 'low investment-weak reform' and a preferred scenario of 'high investment-strong reforms'. Water investments and policies are central differences in the two scenarios: Scenario A 'low investment-weak reform', 0 percent water growth and 10 percent drop in usage compared to Scenario B: 'high investment-strong reform', 5 percent water growth and 10 percent increased usage.

Box 1

Projections for 2020

POPULATION	1 330 million
URBAN POPULATION	Low: 465 million; High: 590 million
SLUM POPULATION	Low: 85 million; High: 130 million
SOLID WASTE DISPOSAL	100 to 110 million tonnes
COAL DEMAND FOR POWER GENERATION	Low: 817 million tonnes;
	High: 2 016 million tonnes
CROPPING INTENSITY	More than 1.5
NET AREA SOWN	Constant at 141 million ha since the 1990s
IRRIGATION INTENSITY	Around 1.75
WATER SHORTAGE	10% to 25% between 2020/2050
NOISE LEVELS	Twice the norms in trend forecast
AIR POLLUTION	Two to 2.5 times norm in trend forecast

Source: Alagh, 2000d.

Table 3 shows the importance of the growth of irrigation and improved water use on poverty and malnutrition amelioration. By 2010, if land and water scarcity and degradation are avoided by better policies, river basin management improves, user-managed irrigation is implemented, water rights, pricing and markets are introduced and groundwater management is enforced, average per capita daily availability of calories in developing Asia will rise from some 2 500 kcal per capita in

2001 to 2 850 kcal. By 2020 or before, malnutrition can be eliminated. Land and water policies must be part of a larger reform of good governance and economic reform.

EMERGING SCARCITIES

Some studies of large developing economies including China, Brazil, India and Indonesia indicate that in terms of current and anticipated growth trends (apart from shortages of water for direct use), sustainable requirements for water to intensify land use in agriculture, forestry, urban sanitation and energy requirements will require sharp breaks with past attitudes and policies. Business as usual will not work. An Indian illustration shows that cropping intensity must rise dramatically, non-coal-based energy expand rapidly and that BOD disposal strategies will be critical as Box 1 shows. Similar scenarios were presented for China and Indonesia.

While present studies suggest technology and 'appropriate' institutions as an urgent panacea, the work is of a preliminary nature and needs considerable focus. Most models bring out the cost of delay in starting on the preferred policy paths.

Studies bring out the conflict in sharing of water between agricultural and non-agricultural needs and rural and urban requirements. Such conflicts show up in 'land scarcity' or sustainability crises, for example deforestation. Improved water use is invariably an important part of the mediating strategy in terms of allowing intensive agriculture and releasing land for sustainable use. In India, Singh (1994) suggests that non-agricultural land use is growing at 6 to 10 percent per decade. With arable area not expanding, he calls for a land use policy. Alagh (2000d) calls for a changed emphasis from urban land ceilings and control of each plot to a land use and transportation policy, showing that the pattern of urbanization can determine the quantum of BOD and water demand. Brown (1995) projects worrisome projections for land conflicts between urban and rural use in China, are different from the lower figures in UNU-IAS (Lindert, 1996).

There is much variation in estimates of waterlogged and otherwise degraded land. For India estimates vary from 50 million ha to 13 million ha. There is similar variability in global estimates. The author tends to agree with Alexandratos (1995) that many so-called global estimates are simply informed opinions, problems are less severe and sustainable development strategies can make an appreciable impact.

Pricing of water use is clearly important when such scarcities emerge. This is particularly true for irrigation and groundwater use. Investments in technology are also seen as particularly beneficial, both on water supply and distribution and on water using activities like newer crop varieties (ADB, 2000). In projections for the United Nations University regarding India, Alagh (2000d) shows that there are at present no water saving technologies in the field. Hybrid paddy in both India and China needs more water per hectare than HYVs and is also more demanding in terms of stress. But more appropriate cropping sequences across agroclimatic regions will save water. It would be useful to precisely outline the role of water development and management strategies in some large countries with different agro-climatic regimes which are a 'World within the World' (Alagh, 1994) to systematically determine these issues.

INSTITUTIONS: STRUCTURE AND INCENTIVES

Near consensus among water sector institutions focuses on three essential elements: privatization, decentralization and the role of the market. As with earlier World Bank research, a recent study on Asian agriculture by the Asian Development Bank (2000). There is much to be said for these

approaches. Agriculture is atomistic: farmer response to economic incentives and direct intervention by large government agencies regarding input or output is often counterproductive. In Asia the powerful work of Hayaami for example has shown the vitality of peasant markets (Hayaami, 1981). Continued agricultural growth reduces unemployment and poverty. In good soil and water conditions, given available market infrastructure, the competitive model works.

The state can play a role in technology generation, infrastructure creation, introducing new technology, market intervention and risk reduction, but the success or failure of the green revolution still relies on the farmers themselves and their organization. It is now recognized that hunger, deprivation and unemployment were minimized in areas where widespread agricultural growth took place, generally supported by market incentives. Growth was fast in areas with good soils and assured rainfall or irrigation, but arid regions, hill slopes, difficult aquifers – hard rock or coastal areas prone to salinity ingress – were bypassed because they were problem areas. Peasants are rational. Markets work here as well but reality is more complex. The performance of areas with low and/or uncertain rainfall regimes was poor and uneven. 'Marketization', 'commercialization and sometimes 'globalization' led to serious problems, with socio-economic deprivation, destabilization, and environmental disaster, as two sides of the same coin. Helleiner, later chair of the International Food Policy Institute (IFPRI), showed that associated with the disasters in Saharan and Sub-Saharan Africa was the systematic decline of peasant and community organizations in rural areas (Helleiner, 1986).

Varied agro-economic regimes in difficult areas historically evolved to a balance between social activity and resources because of traditional economics and culture related to soils, climate and resources. These are again being incorporated in watershed and other water and soil development projects. This traditional equilibrium was in many cases cruel, especially to women. Nonetheless society had coped with the crisis of resource endowments. This fragile equilibrium was being disturbed, before the current emphasis on globalization. Diminishing mortality, rising population pressure, commercialization and marketization were leading to the breakdown of traditional practices. Increasing desertification, soil erosion, flood proneness and forest clearing could be traced to water harvesting or drainage breakdown and rising commercialization – including a decline of in kind labour contributions.

These vicious circles coexist with positive experiences. Some households and communities have coped with similar fragile land and water endowments and have met energy, food, basic employment and income deficits in a sustainable manner. While in the early 1990s these were considered 'experimental' in nature, today they are of such magnitude to be called 'alternative' organizational methods rather than demonstration projects. In the late 1980s under the author's supervision, eight case studies were studied by independent research institutions in India, where community effort with private landownership, food and energy gaps were met in a sustainable manner. These studies described the land and water development project implemented in a defined homogenous micro geographical area such as a hill slope, a micro watershed, a tributary branch, an aquifer, or an irrigation distributory (Alagh, 1991). They estimated land and water development costs, labour, 'outside finance', output as food requirements met, energy requirements met and fodder supplies. There were estimates of 'economic rates of return on the investment', i.e. at accounting border prices, with a shadow wage rate 25 percent higher than the market rate. Financial rates of return at market prices were also estimated. The studies showed high economic rates of return (18 percent plus) making them very productive investments.

The initial studies were widely replicated (Chopra and Kadekodi, 1993). A recent study by the United Nations University and an ADB review of Asian agricultural experience has some insights (ADB, 2000). There is yet no theory of such development, but there are preliminary pointers which we review. The projects examined have varied considerably. Watershed development for settled agriculture, alternate tree crops, salinity reclamation, farmer-run lower level irrigation systems,

aquifer management in difficult situations, such as coastal aquifers, tribal lift irrigation cooperatives, and tank irrigation have been reported and studied.

The success stories are community and leadership based, with leadership coming from diverse sources – an NGO, an army retiree, a concerned civil servant and a scientist. The leaders either had science backgrounds or knew enough to adapt from nearby science institutions. Organization structures were mixed neither purely private nor fully community-based control. The leadership invariably argued for aggressively functioning markets, private landownership and household level agricultural operations, but there was limited, well-defined land or water management cooperation. This could be drainage, soil shaping, contour management, improvement and management of lower level canals, controlled grazing and so on.

Even though the economic rates of return were high, they incurred financial losses. These have at least been estimated in the initial stages of operation. The reasons are not fully understood. Some pointers are to the effect that invariably output prices are lower than border prices and input prices are higher. Markets are poorly developed in fragile regions and soil; amendments, pump sets, seed prices and interest rates will be higher than in developed regions Another reason could be that input rates may in poor soils be high initially and may go down as the organic composition of the soil improves. In saline lands for example, initial irrigation requirements for leeching may be high, seed rates and soil amendments may cost substantially and low value crops may need to be grown in rotation to improve the organic composition of the soil. Financial support to such efforts also needs effort at institutional reform. Collateral becomes difficult to organize in partial cooperative forms of organizations and bankers generally find community collateral unacceptable. Many of these projects require lending through a weather cycle, for example a watershed development cycle. The fact that that some of the resource requirements of such projects emerge from labour contributions of the community makes it difficult to work out margin requirements. There is an interesting discussion of reform issues from a bankers perspective to refinance the loan component of such projects in an annual report of a national bank for agricultural and rural development (NABARD, 1991).

There is need to design a policy of initial and targeted subsidies for such efforts and also financing reform. This is a complex issue. The intention has to be to help those who help themselves. But the rules of such help systems are not easy to design, as they have to work at a highly decentralised level. The economic imperative will be to operate a hard budget constraint; otherwise resources will be wasted. On the other hand viable projects must be supported. There are also questions of financial reform mechanism design. Until recently, it was easier to buy a tax-free New York Municipal corporation bond than a local bond for infrastructure support of the kind being discussed. There is now a vast literature on irrigation performance and management systems. Many case studies are available, including those initiated by the International Institute of Irrigation Management. More recent attempts have been made to generalise from them. The need to integrate new technology with community and socio-economic institutions has been indicated (Small and Carruthers, 1991; Ostrom 1994, 1996 and IIIM studies summarized in Shaul, Manor and J. Chambouleyron, 1991). The relative inefficiency of state-run systems is known, and their impingement on historically evolved communal systems (Wade, 1982 and Chambers, 1988; Siy, 1987; de los Reyes and Jopillo, 1987). Newer studies report on the fragile nature of traditional irrigation system rules, their vulnerability to outside interference and commercialization – particularly in terms of contributed labour and maintenance. The struggle to define rules which permit local initiative without open-ended subsidies is recognized. Moreover there is now an awareness that disincentives to perverse behaviour must be put in place. Paradigms for land and water policies in different agro-climatic regimes must be developed, with organizational and financial rules for practical working systems.

An emerging literature questions the proposition that decentralization and self-management will automatically increase performance levels. Government expenditures in the water sector may decline. Lacking a policy to monitor performance and anticipate systemic solutions to emerging problems is a problem in itself. Empirical studies show mixed results from some decentralized participatory experiments (Vermillon, 1997; ADB, 2000a). ADB quotes a study by Rice that poor operations and management have a little impact on irrigated crops (ADB, 2000b).

On land and water and problems of ecologically fragile areas, Agenda 21 seeks a comprehensive approach and asks for implementation of sustainable development investment plans and strategies at national level through international cooperation. The Technical Annexe to The Hague Meeting Pronk-Mahabubul Haq paper by I. Sachs commends an agroclimatic approach to land and water development costs.

Alagh (1991b) gives many examples of watershed development projects with a short-pay-back period. Techniques for such projects are well known and their impact at community level would be favourable. Yet they need public funding for the front-up costs. Alagh argues for agro-climatic planning in terms of alternative agricultural and framing systems to overcome the shortcomings of favoured crop/region approach (Sachs in Pronk and Haq, 1992).

The literature on capacities and designs leads to interesting questions. On the one hand it is argued that there has been an excessive emphasis on building physical capacities and management and institutional issues have been ignored in irrigation systems. Traditional management systems in particular it is argued are being swamped. On the other hand it is argued that physical capacities have fallen short (IMMI, 1987, 1991). Ambler's plea that "The link between techno-managerial arrangements and local performance goals must be understood before measuring performance or proposing interventions" probably contains an important clue (Ambler, 1991). Alagh and Buch (1995) have shown that in planning distribution systems in developing countries using hydraulic techniques developed elsewhere – for example full supply hydraulic distribution systems operating in the developed world – need much innovative systems work. In the California aqueduct and the Canal de Provence, there were few farmers as compared to the examples they studied. The behaviour of large farming populations must be studied and built into capacity and design parameters. They show the use of acreage response studies and water allocation and distribution systems working on conjunctive use principles with the operation authority monitoring and if necessary intervening. The Mekong Basin Indicative Plan asks for such work to be intensified and refers to the Alagh-Buch model as "an excellent example of how agricultural econometric models are used in water resource planning to help design and manage large irrigation systems." (Mekong River Commission, 1996). This is an area of high priority work for project design and policies.

While recognition of water rights will generally lead to smaller dams, the need for basin and interbasin transfers of water will remain. For example the Mekong agreement stipulates cooperation on maintaining flows "To enable the acceptable natural reverse flow of the Tonle Sap to take place during the wet season". The agreement emphasizes sustainable development (article 6) and shows sensitivity to water rights not seen earlier. Such awarenesses will have important design and structural implications on interdisciplinary work not seen earlier, when the economist, social anthropologist and social worker were seen as add-ons *after* project design rather than a part of the engineering design team. Replication of these examples will need systematic work, training and manuals.

LOCAL AND GLOBAL RULES

The problem of imposing budget constraints at local level and helping those who help themselves is difficult to address. Another way of setting the problem is to harness the great vitality of decentralized markets in replicating widespread rural growth within the core areas of local and global concern. Some lessons:

- Financial institutions must design structures to enable community collateral such as self help financing groups. Land and water development groups, local infrastructure projects in road or communication sectors (Alagh, 2000), making products developed in R&D institutions, training for production with improved techniques, and market development schemes developed by local and community groups are other examples (ADB, 2000a);

- Lending through a weather or project cycle is necessary. NABARD began such a scheme in 1991, gave it up in 1993 and is again starting it now (Reserve Bank of India, 2000);

- Developing 'policy champions' to set administrative, financial and procedural issues at local, regional and national levels, when problems arise with these kind of development strategies. It is reasonably certain that problems are going to arise in development experiments which are off the beaten track. The question then is, is there anyone in the policy decision making structure to sort out the problem. ADB reports in a study of farmer managed irrigation systems, that failures were those where such support did not exist. Failure here is defined as performance levels in water delivery lower than by government agencies (ADB, 2000a).

Such problems arise in part because existing legal and administrative systems and financial rules are structured for formal organizations in the public or private corporate sectors, as are global financial institutions. Newer institutions with strategic mixtures of organizations and styles – such as cooperatives and corporations, NGOs and government, NGOs and cooperatives – do not have a level playing field: for example a loss-making subsidized electricity system can underprice a renewables group and drive it out of the market. Legislation for a recommended structure for cooperative companies is in India's Parliament (Alagh, 2000c). Eventually subsidies and protection given to established groups must be withdrawn. In the meantime equal protection must be given to each group. Incentives and disincentives for such growth should begin with basic policies such spending cannot exceed available resources. Resources which are short or binding constraints at national and global levels are elastic at local levels but using them requires policy changes at higher levels. For example, it is easy to buy a New York City tax free bond, but little attention has been given to developing markets for such bonds to raise funds for local bodies in developing countries – and the fiscal reform that must precede them, as demonstrated in Ahmedabad (Vaidya, 1999).

The last three problems essentially work out that the reform process has to be fairly deep rooted for widespread land and water based poverty reducing growth processes to take place. This might be the appropriate tone to conclude.

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Funding investment in land and water

INTRODUCTION

This paper advocates enhanced financing support for sustainable agricultural and rural development (SARD). It examines the trend in resource flows to agriculture and explores issues in sustainable agricultural development. It also presents an overview of innovative financing mechanisms and the principles of a framework for the coherent and effective use of investment resources.

RESOURCE FLOWS TO AGRICULTURE: INTERNATIONAL FINANCIAL FLOWS

International financial flows are crucial to sustaining growth in developing countries. The financial crises in the second half of the 1990s adversely affected private financial flows and their recovery has continued to lag output and trade growth. Moreover, the cyclical slowdown of the global economy could well dampen these flows. However, this decline in private flows reflects some improvement in their quality as volatile short-term flows have fallen sharply. Foreign direct investment (FDI) is more stable. Countries experiencing rapid FDI growth have benefited from augmented domestic savings, financing for new investment opportunities, and exposure to international markets. The potential for productivity growth through private capital flows has probably increased because of the growing importance of knowledge as a production input. On average, private capital inflows raise domestic investment in a ratio of almost one to one. However, the effect is strongest for those countries that are least integrated with international financial markets. Thus, the association between foreign inflows and domestic investment is strong in Africa.

However, private flows favour high performing economies. The benefits are available mainly to countries that have a strong capacity to absorb them. This underscores the importance of a hospitable business climate in attracting and sustaining FDI flows. Short-term portfolio flows reinforce positive growth dynamics but decline in conditions of economic adversity. Moreover, their volatility can impose considerable costs. This calls for capacity building support to manage volatility and safeguard domestic financial stability.

Total net external flows to developing countries peaked in 1997 (Table 1). Net official flows have since declined to 63 percent of their level at the beginning of the decade. Net private flows (both capital and FDI) have also declined since 1997 but are still nearly 6.6 times higher than official flows. However, for many developing countries official flows provide important support to their economic growth momentum while their market-based reforms continue. To date, FDI flows have not been sufficiently responsive to these changes because of risk perceptions about the legal and regulatory frameworks and contract enforcement and dispute settlement mechanisms.

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The share of FDI in net private flows increased from 58 percent in 1997 to 69 percent in 2000, about US$5 billion more than in 1997. FDI flows to low-income countries quadrupled between 1991 and 2000, but remained less than 2 percent of their GDP. The share of the low-income countries in all FDI flows to developing countries fell to 7 percent (13 percent in 1991). Sub-Saharan Africa has had particular difficulty in attracting FDI. This is due to insufficient market size, poor infrastructure, political uncertainty, corruption and restrictive policy regimes. The top ten developing country recipients of FDI (China, Brazil, Mexico, Argentina, Malaysia, Poland, Chile, the Republic of Korea, Thailand and Venezuela) accounted for 74 percent of total FDI flows to developing countries in 2000, amounting to 3.8 percent of their GDP.

Where net private capital flows and FDI decline, the need for official aid flows comes into sharper focus. Current levels of foreign aid, at some 0.24 percent of annual GDP, fall short of the 0.7 percent target set by developed countries. The actual aid falls short of that target by some US$100 billion a year. Overseas aid to Africa fell from US$32 per person in 1990 to US$18 per person in 1998.

International official resource transfers provide about US$5 billion a year, about 10 percent of official development assistance (ODA), to fund international public goods, e.g. health, agricultural research and environmental protection and an additional US$11 billion finances complementary domestic infrastructure.

TABLE 1
Net long-term resource flows to developing countries, 1991-2000 (US$ 000 million)

	1991	1995	1996	1997	1998	1999	2000
Total	123	261	311	343	335	265	296
of which:							
Official flows	61	55	32	43	55	45	39
Private flows	62	206	279	300	280	219	257
Of private flows:							
Capital markets	26	99	148	127	104	34	79
FDI	36	107	132	173	177	185	178
Share of developing countries (%)							
In global total private flows	12	12	13	14	10	8	8
In global FDI	22	32	35	37	26	19	16
FDI inflows as share of total developing-country FDI							
Low-income countries	13	13	14	11	8	5	7
Least developed countries	5	2	2	2	2	3	3

The proportion of sectorally allocable aid reaching agriculture, forestry and fisheries fell sharply from the mid-1970s to about 20.2 percent in 1987-89 and then to 12.5 percent in 1996-98. The real value of net aid disbursed to agriculture in the late 1990s was 35 percent of its level in the late 1980s. The share of agricultural lending in the loan portfolio of the World Bank fell below 10 percent in 2000, compared to an average of 14 percent for the decade ending 2000. Thirty years ago the figure was 40 percent. In constant 1995 prices, total commitments for agriculture are 8 percent below the level in 1990. Contributions from bilateral donors, mainly countries in the Development Assistance Committee (DAC), were about US$4.3 billion in both 1997 and 1998. The increased levels of assistance in 1997 and 1998 over that of 1996 were due entirely to increased levels of multilateral

assistance, particularly from the International Development Association (IDA), while bilateral assistance was actually lower than in 1996.

The share of agriculture in total government expenditure in developing countries ranges from 0.015 percent to 23 percent, with this share being lower than 10 percent in 90 percent of cases. Countries with high levels of undernourishment are also those with severe budgetary constraints. This points to the case for a larger flow of concessional development assistance to such countries to effectively face the challenge of food insecurity and undernutrition.

Investment needs

The total annual gross investment needs of agriculture in the developing countries (primary agriculture, storage, processing and support infrastructure) would be about US$180.4 billion for the period up to 2015. A continuation of current annual investment rates until 2015 would be insufficient to achieve the World Food Summit (WFS) target. The expected shortfall averages 12 percent for all developing regions and is 38 percent for sub-Saharan Africa.

Programmes such as the Soil Fertility Initiative, the Integrated Land and Water Management Action Programme for Africa, the International Programme of Land Quality Indicators, the Inter-American Water Resources Network, and the Critical Ecosystems Partnership need financial resources for implementation, up-scaling and replication. The sustainable development of land and water resources calls for increased resource flows from domestic and external sources, but also for a more effective use of such resources and improved frameworks of partnership and aid coordination among all stakeholders.

International development goals

The DAC guidelines on sustainable development strategies stress the need for deep structural changes in the economy, society and politics. Land and water issues are linked to the development goals of poverty reduction, food security and nutrition, and to the implementation of national strategies for sustainable development by 2005.

There is a trend towards the rural poor depending increasingly on non-farm sources of income generation. The share of non-farm employment in rural employment among the rural poor ranges from 30 to 50 percent. Despite this positive trend, the dependence of the poor on the natural resource base and on agriculture poses a challenge for the sustainable development of land and water resources. Addressing opportunities and constraints of smallholder agriculture requires both technical and institution-building support and financial resources for investment in rural infrastructure. Without such resource flows, the realization of the international development goals is not possible within the specified timeframe.

Improving support for international development

Governments can and must do more to encourage public awareness of assistance activities and support for international cooperation for development. This calls for: establishment of clear goals for development policy; reorientation of development education to portray issues objectively; an intensified effort to assure efficient and effective programme management; awareness that development cooperation deserves support because of the mutual interests that it serves and because of the moral imperative of helping others to help themselves and improving resource use.

The main measures to increase the effectiveness of ODA are: implementation of a holistic and cross-sectoral approach to sustainable development; developing a strategy for country leadership with

mutual responsibility among partners for development outcomes and distinct accountabilities; emphasizing partnership and collaboration among governmental and non-governmental actors at national level; ensuring that aid coordination integrates external assistance with the development priorities of the recipient country. Donors and recipients should adhere to strategic objectives and investment programmes; placing responsibility for aid coordination primarily with the recipient country. Two elements of an enabling environment are policy performance and institutional quality; and introducing results-based frameworks for assessing aid coordination.

There is a need to provide considerable capacity-building support in order to help governments nurture policy reform, strengthen aid coordination capacity, and reach partnership agreements with donors. The agreements should delineate mutual responsibility for development outcomes and the distinct accountabilities of each partner. The Poverty Reduction Strategy Paper (PRSP) will serve as the main instrument for implementing these recommendations.

ISSUES IN LAND RESOURCES DEVELOPMENT

The deployment of resources through financing mechanisms and modalities involves three inter-related segments: (a) SARD; (b) land degradation; and (c) natural resource management (NRM). Water resources constitute a distinct cluster. The investment dimension of these segments encompasses key issues:

- economic and policy measures to increase sustainable productivity;
- the degradation of both marginal and high-productivity irrigated lands;
- sustained cultivation of sloping lands;
- deforestation and loss of biodiversity; and
- declining reserves and increasing competition for water resources.

The main planks of the integrated and participatory strategies to address these issues are:

- integrated systems approaches to sustainability issues;
- integrated research programmes to find least-cost, quick-return conservation methods;
- integrated approaches to pest, disease and weed management;
- improved information on declining productivity and natural resource degradation, and on the methods for their alleviation; and
- a search for solutions in the context of institutional, environmental and economic interfaces.

Sustainability

SARD implies jointly producing food and other goods for farm families and markets, and also contributing to frameworks to provide a range of public goods. However, SARD does involve difficult choices and trade-offs. It is also not easy to develop incentive frameworks that can ensure optimal solutions in terms of costs and benefits. An analysis of SARD issues requires a comprehensive framework that shows the interrelationship of all aspects of development.

Production gains from intensification

Agriculture is the key sector for generating incomes and employment in both farm and non-farm economies in most developing countries. Therefore, agricultural intensification holds great promise as an instrument to simultaneously alleviate poverty, meet food needs, and avoid exploitation of the natural resource base.

To help ensure global food security, the developed countries need to aim for sustained gains in productivity in order to provide stable food stocks to meet emergencies or to fight hunger and malnutrition in pockets of chronic poverty and vulnerability.

Agricultural intensification in developing countries

In the last 40 years, the doubling of cereal output has come from three sources: area expansion, intensification and yield increases. The area under irrigation more than doubled between 1950 and 1980. However, its rate of growth has since slowed substantially. In many areas, physical and technological constraints are likely to restrain large-scale conversion of potentially cultivable land. Increased cereal production has to come primarily from increased productivity or higher yields, but without compounding environmental problems such as erosion and salinization. In some countries annual losses in production potential attributable to soil depletion may reach 1.5 percent of GDP. Expanded production and employment in agriculture is usually feasible to the extent that:

- agriculture's total productivity factor grows enough to outweigh any falls in net farm prices;
- farm resources, especially land, are redistributed towards small and family farms;
- technology changes in a labour-using way, or incentives change so that farmers use a larger proportion of land labour-intensively.

Agricultural intensification need not degrade the environment, but inappropriate and mismanaged intensification can lead to environmental degradation. Rural poverty causes a more serious environmental problem in developing countries through the forced exploitation and consequent degradation of environmentally fragile lands. On balance, the potential for increasing yields through intensification outweighs the alternative of expanding acreage.

Large pockets of rural poverty are concentrated in dryland areas (fewer than 120 growing days per year). Drylands extend over at least 20 million km^2 with a population approaching 500 million. A central precondition for their development is the assignment of a high priority to drylands improvement. Projects and programmes to combat land degradation need to be flexible and include:

- Strengthened information and monitoring systems, especially for drought preparedness.
- Integrated programmes and policies which balance conservation and production objectives.
- Improved dryland resource management through environmentally sustainable practices.
- Programmes to eradicate poverty and promote alternative livelihood systems.
- Support for indigenous technologies and local participation.
- Enhanced national capacity for rural development.
- Support for the control of population growth.

Intensification will have to meet the expected doubling in food requirements by 2050. Therefore, the sustainable use of land, whether in high potential or dry areas, becomes crucial. The FAO SOFA 2000 calls for a new green revolution, which involves resource-poor regions and farmers and so-called orphan species and varieties.

ISSUES IN SUSTAINABLE WATER RESOURCES DEVELOPMENT

Principles for effective water policy

The emerging principles for the efficient and sustainable use of water are:

- Undertake national water resources development and management in a holistic and sustained manner to meet national development goals and protect the environment.
- Decentralize the planning, development and management of specific water services to an appropriate level responding to basin boundaries.
- Delegate the delivery of specific water services to autonomous and accountable public, private or cooperative agencies providing measured water services in a defined geographical area to their customers and/or members for an appropriate fee.
- Allocate shared water resources efficiently for the mutual benefit of all riparian users.
- Enable participatory and consultative activities at each level.
- Ensure a commitment to sustained capacity building, monitoring, evaluation, research and learning at all levels.
- Ensure sustainable water use in society (with incentives, regulatory controls, and public education promoting economic efficiency, conservation of water resources, and protection of the environment) within a transparent policy framework.

An ideal institutional framework for rational water resource management would include:

- A decentralized, accountable structure that is coherent at each layer of administration.
- Self-management of independent bodies and self-financing at user and higher levels of activity, according to users' ability to pay.
- Market mechanisms as an integral part of water allocation.
- An enabling role for government, with key responsibilities for capital investment, supporting legislation, data collection and processing, and support for basic technical R&D.
- A comprehensive and consistent legal code which clearly defines the water rights and responsibilities of individuals, groups, agencies and government bodies.
- A set of procedures for *de jure* and extra-legal arbitration of disputes and established enforceable penalties for misuse and degradation of water resources**.**

Irrigation, drainage and groundwater development

Investments to promote efficient systems of surface irrigation and drainage and groundwater abstraction assume crucial importance within the framework of integrated water resources management policy. About 17 percent of all cropland is irrigated, accounting for some 40 percent of food and fibre production. Irrigated agriculture is highly water intensive, claiming nearly 70 percent of world water abstraction (over 90 percent in agricultural economies in the arid and semi-arid tropics). Wasteful irrigation practices not only entail the loss of precious water but also cause waterlogging and salinization. More than 10 percent of the world's irrigated land suffers from varying degrees of salinization, and the extent and severity of this phenomenon are growing. In addition, seawater intrusion can damage aquifers irreversibly. Despite large investments and subsidies, irrigation performance has not always fulfilled expectations in terms of yield increases and efficiency of water use. Agriculture is also a relatively low-value, low-efficiency and highly subsidized water user. This situation is not sustainable.

Food security is closely linked to success in water control. Moisture control at root level allows for the maximization and stabilization of production. Success will not come from expansion

alone (more dams and canals, larger tracts of land levelled and watered). Increasingly, it must come from improved management and rehabilitation of inefficient systems, and the substitution of traditional systems by systems based on accurate technology. Achieving this will require funds and qualified, capable farmers and managers.

From the perspective of sustainable water resource management, Table 2 summarizes some examples of actions to be encouraged/discouraged in the irrigation and drainage subsectors.

Table 2
Issues in irrigation and drainage

Encourage	Discourage
Cost recovery	Non-transparent, non-targeted and non-temporal subsidies
Management of irrigation units by farmers and/or user associations	Emphasis only on main delivery and drainage systems without consideration for in-farm drainage
Added emphasis on in-farm operations	Groundwater depletion
Rehabilitation of existing systems	Conflicts with other uses
Economic incentives for water conservation, especially groundwater	
Maintenance of investments	
Financial sustainability	
Complementarity with other uses	
Farm drainage as part of the project	
Adequate disposal of irrigation return flows as an integral part of the project	
Explicit consideration of policies for tariffs and subsidies	

OTHER PRIORITY ISSUES IN SUSTAINABLE AGRICULTURAL DEVELOPMENT SYNERGIES

To exploit the synergies between the Rio Conventions on desertification (UNCCD), biodiversity (CBD), and climate change (UNFCC), it is necessary to operate concurrently at four levels:

- awareness building and information dissemination;
- programming to build complementarities in respective country-driven projects and programmes, or subregional/regional initiatives;
- implementation of programme elements requiring joint or mutually reinforcing complementary actions;
- building databases and information exchange.

Climate change, global warming and water resources

The impacts of climate change on water users and the water environment will depend on the nature of the institutions managing water and the physical infrastructure. Among the factors that influence the ability of a water system to respond to change are financial resources and technical expertise. The focus of water management is turning towards flexible, integrated systems, incorporating both supply and demand management. Such systems are inherently better able to cope with climate change, and are easier to adjust as more information appears.

The inclusion of soil carbon sequestration into future arrangements for carbon sequestration is an important development for the role of land-based activities within the framework of the Clean Development Mechanism (CDM). This issue calls for a more integrated approach to land productivity, soil fertility, forestation and biodiversity. The potential for soil carbon sequestration may be as high as 40 percent of the total amount of annual atmospheric increase in CO_2 concentration. Moreover, the appropriate choice of crops coupled with appropriate land management will lead to increased carbon retention. The Global Mechanism (GM) is associated with innovative ways of activating the flow of new funds for CCD implementation. However, many operational and measurement issues remain before activating the CDM as a source of fund raising.

FAO and IFAD have agreed to implement a programme to strengthen regional and national capacities to define strategies focused on greenhouse gas emissions for the benefit of the sustainable management of natural resources of the region. Forestry and agroforestry can compensate for greenhouse gas emissions by creating new sinks for carbon dioxide, and by protecting existing forests that are carbon stores.

Valuation of environmental effects

The reasons for unsustainable practices and environmental damage lie in policy and market failures to value environmental resources and to incorporate environmental costs in prices. Part of the cause lies in unclear or non-existent property rights.

Valuing *in situ* natural resources solely as raw materials ignores their role in the earth's life support systems. This requires attaching non-monetary weights for forests, biodiversity, non-renewable resources, and global commons. Such a valuation system would establish linkages between the economic goals of profit maximization and environmental sustainability. Such systems of green accounts seek to prevent the overuse of natural resources. However, translating this concept into practice raises many technical issues. The precise economic value of ecological assets is difficult to assess. This is due partly to the lack of information on the market value of ecological goods and services and partly to uncertainty about the dynamics of ecosystems, as well as problems of quantifying certain non-market values. Many of the environmental effects are manifest either at distant locations (downstream effects) or in the future (the gradual depletion of soil nutrients). The effects may be *in situ* or off-site. However, quantifying such effects on ecological assets would require monitoring systems to collect and analyze data for economists to use in attaching values to ecological damage in relation to losses in productivity and sustainable development. One analytical tool is the social rate of discount. Apart from various technical issues involved in its application, there is also some apprehension that the use of such discounting may work against the interests of the natural environment. The higher the discount rate, the less long-term environmental damage will appear to matter, and the less attractive will investments to conserve the environment appear. However, the answer lies in incorporating a criterion of sustainability into certain aspects of decision making. Table 3 summarizes existing economic principles and their extensions at project, sectoral and macroeconomic levels.

One method of project appraisal combines the concepts of economic feasibility, acceptability, and sustainability. In its application to a watershed development project, feasibility is measured by the change in sustainable income for the successive generations of project households as seen from today; acceptability by the average annual income which the current generation of project households derives from the project; and sustainability by the tax or subsidy equal to the difference between sustainable and average annual income for the current generation of project households. Internalizing external costs and negative welfare impacts in the project and forcing a sustainability constraint on the project do restrict the scope of feasible projects. However, potential gainers outside the project, either in space (externalities) or in time (sustainability), can be taxed on the basis of part of the gains which

rural development projects may create for them. This approach can help identify win-win investment options.

Such valuation/appraisal exercises require interdisciplinary team efforts within a framework for monitoring the costs of neglecting, and the benefits of, conserving such ecological assets. This needs funding support, as does capacity building of related expertise and institutional frameworks. Synergies between knowledge, environmental protection and investments include:

- Improved collection, transfer and use of agricultural and environmental information;
- Capacity building in approaches/methodologies to identify win-win outcomes;
- Improved environmental standards through incentive frameworks;
- New opportunities for profitable and sustainable environmental investments.

TABLE 3
Techniques for valuing the environment

	MARKET TYPE		
	Conventional market	**Implicit market**	**Constructed market**
Based on actual behaviour	Effects on production, Health Defensive or preventive costs	Travel costs Wage differences Property values Proxy goods	Artificial market
Based on intended behaviour	Replacement cost Shadow project		Contingent valuation

Definitions: Defensive costs: Ex-post costs of mitigating damage. Replacement cost: Future cost of replacing an impaired environmental resource by an equivalent asset, assuming that original resource was at least as valuable as the replacement expense. Shadow project: cost of special project designed to offset environmental damage caused by another project. Proxy goods: Market value of a substitute for an environmental asset that itself is not marketed. Artificial market: Willingness to pay for an environmental asset determined on an experimental market. Contingent valuation: Willingness to pay for an environmental asset or willingness to accept compensation for its loss, determined by direct questions.

Market failures are the result of institutional failures the failure to establish the regulatory framework to: secure property rights, check open access to common resources, enforce contracts, impose and collect taxes, recover costs, and provide transparent rules governing incentives and disincentives, responsibilities and accountability. The key environmental principles are: proportionality; the polluter pays; prevention; and common but differentiated responsibility.

Technology and institutional modernization

A major weakness of agricultural research and technology generation and diffusion is that the national agricultural research systems (NARS) are underfunded and poorly equipped. Their research priorities do not fully incorporate the problems of dryland agriculture and resource-poor and low-potential areas. The linkages with extension services and farmers, and with international and regional agricultural research centres, leave much scope for improvement. It is necessary: (i) for farmers to adapt their traditional systems to a more competitive market environment; and (ii) to look for less

costly, more responsive and more pluralistic transfer systems that can reach a wider clientele of small producers.

Another issue is the decline in public-sector agricultural support services, particularly in remote areas. There is a case for promoting efficient private-sector services, such as expanding NGO extension systems, provision of group-based financial services by intermediaries, and other forms of participatory credit delivery. There is a need for institutional decentralization and representative local structures to motivate and supervise grassroots rural development initiatives.

New techniques aimed at promoting sustainable intensive farming systems need to be developed and disseminated. Such techniques relate to soil and moisture conservation, soil fertility, crop protection, the management of new crop varieties, and water harvesting.

There is a strong case for strengthening programmes and funding to accelerate the implementation of CGIAR research programmes through collaboration with other agencies. CGIAR recommends earmarking an increasing proportion of funding for sustainability-related research and providing it in the form of incentives or seed money to foster consortia and networks.

Other institutional issues

Institutions affect development outcomes in economic and social fields. For example, uncertainty of tenure is usually a deterrent to long-term sustainable land use. Ambiguities relating to usufruct rights of land, water and trees tend to contribute to environmental degradation. Other institutional aspects include the absence of clear community mechanisms for the upkeep of public assets and infrastructure, a lack of financial services, and the marginalization of women. The absence of micro-credit institutions discourages investment in soil and water conservation measures, particularly if payback periods are relatively long.

A priority area is the need to strengthen national and local environmental management capacities. Addressing global environmental problems requires: (a) integration of these concerns into national policy making; and (b) improved use of scarce resources through financial leverage and market-based approaches. Institutional frameworks need to be developed to promote and implement interventions to address cross-border concerns.

FINANCING SUSTAINABLE DEVELOPMENT

International development cooperation

The rationale for development assistance has changed. Good governance is now an important component of the broad framework of policy dialogue. There is an emerging consensus that poverty reduction and growth must be at the heart of the agenda for sustainable development. Its basic principles are:

- Development is a process of societal transformation that takes place over time;
- A comprehensive approach to development and a multidimensional view of poverty;
- Faster growth is essential for sustained poverty reduction, and greater participation of the poor enhances growth potential;
- Country ownership of the goals, strategy and direction of development and poverty reduction (shared ownership by representative segments of society) is critical;
- The development community as a whole must work closely together;
- A clear focus on measurable development outcomes.

The main instruments to translate the above principles into action are:

- Country-owned poverty reduction strategies to provide the basis for donor concessional assistance (particularly World Bank and IMF lending), and guide the use of resources freed by debt relief under the enhanced Highly Indebted Poor Countries (HIPC) initiative;
- The World Bank's Comprehensive Development Framework (CDF) or its equivalent the UN Development Assistance Framework (UNDAF) at country level as a basis for coordination of programmes and action plans based on the country's PRSP. The CDF represents an approach to policymaking based on a greater balance between the economic, human and structural elements of development, and on new partnerships that support countries in achieving this balance.

This framework would ensure coherent strategies which reflect ownership by a broad spectrum of domestic stakeholders. It would also improve donor coordination and serve as a platform to focus the analytical, advisory and financial resources of the international community on achieving monitorable results. However, implementation is a complex process involving many country-level trade-offs and tensions. Apart from capacity constraints in fully articulating strategies and action plans, the process involves conflict resolution between sectors, implementing agencies and public interest lobbies. The World Bank recommends:

- more deliberate use of lending and non-lending tools to foster consensus through increased local involvement and more widespread dissemination of analytic work;
- more use of pilot projects to test new approaches;
- greater use of advisory services and flexible lending instruments to nurture policy change.

The framework implies a greater selectivity among donors in allocating ODA resources. The case for increased financing for development rests not just on the principle of universality, but on policy orientation and performance. Developing countries need to demonstrate their commitment to, and progress in, undertaking market-based reforms. Moreover, their development strategies should be in tune with the objectives of good governance, poverty reduction, basic health, sanitation, and education. Another element of selectivity lies in the policy of individual bilateral donors in terms of the focus of their development assistance on a narrow set of priority areas and countries.

Developed countries channel a part of ODA as contributions to the core funds of multilateral institutions, or as trust funds. Through their support to a developing country, major institutions, e.g. the World Bank Group and the IMF, also trigger private capital flows by lowering private sector risk perceptions or more directly as part of a financing package. Furthermore, multilateral organizations of the UN system mediate with developed member countries to leverage financial resources to provide critical technical and advisory services to the developing countries. For example, FAO has promoted agricultural production and food security in developing countries and has helped raise resources in the fight against hunger and undernutrition through its Special Programme for Food Security (SPFS) in low-income food deficit countries (LIFDCs).

While ODA is the most dependable source of concessional assistance for the low-income developing countries, there is a need to explore other diversified funding channels to enhance financial flows for sustainable development. These include non-traditional sources, such as Arab funds, private endowments, and private financial flows. Private flows comprise foreign direct investment, portfolio investments in marketable securities by foreign financial institutions, foreign bank loans, and export credits. However, such capital flows favour a limited number of better performing developing countries with absorptive capacity and infrastructure to attract private capital. All foreign investments augment the domestic rate of investment. However, private financial flows

pursue profit and not social or development objectives. There are some corporate social investment avenues, but their contribution to resource flows for development is still limited.

Raising resources to finance development

In countries where food insecurity is prevalent, external assistance to agriculture accounts for up to 86 percent of gross domestic investment and 51 percent of government expenditures. The external assistance in such countries has to come primarily from ODA.

FAO estimates that the SPFS requires an annual financing of about US$1.4 billion (US$17 million per country). The projected sources of funding are: the FAO SPFS Trust Fund (US$500 million), recipient countries (US$67 million), bilateral donors (US$137 million), and multilateral financing institutions (US$670 million). The actual mobilization over five years by FAO has been US$230 million, an indication of the scale of underfinancing that has constrained the implementation of the SPFS. To meet this challenge of persistent resource constraints, it is necessary to develop innovative ways to finance the sustainable development of land and water resources on a predictable and long-term basis.

Innovative financing mechanisms

The investments for the agriculture sector and food security form three broad categories: primary production, post-harvest system, and public support. Financing may come from domestic/external private and public channels. More generally, financing may be for: programme or project investments; policy and institutional reforms; capacity-building support; provision of support services; or supervision, monitoring and evaluation. Financing may be in the form of loans or grants provided by donor agencies, or through funds raised in the capital markets (Table 4).

Innovations in financing mechanisms are unlikely to take the form of creating new funding channels. This became apparent during the negotiating process for the UNCCD, which incorporates the Global Mechanism (GM). The GM is a catalyst and facilitator for mobilizing resources for the implementation of the UNCCD in the developing member parties. It should work with all member countries to: (a) improve the efficiency of allocation and use of financial flows at both the supply and demand ends of the resource mobilization equation; (b) to add value through the reorientation of such flows towards the realization of the goals to combat land degradation; and (c) to do so through multi-channel partnerships and by acting as an honest broker between donors and recipients. The main lesson is that the international community is averse to creating new funds or financial mechanisms, and wishes to place greater reliance on the more effective use of existing channels. Thus, the search for innovation must focus on:

- effective coordination among various development partners,
- attention to diverse local conditions,
- adaptations and flexibility in reshaping existing instruments of lending or grant assistance,
- creating a monitorable track record of effective implementation by developing countries.
- using NGOs and civil society in funding arrangements at the grassroots level to prevent leakages or transmission loss in fund flows.

There are also global initiatives to leverage the potential of international financial flows, particularly on the issue of reforming international financial architecture. Although not borne out by trends in financial flows, the process of globalization has raised expectations that private capital flows and trade may gradually displace aid as the dominant financing source for developing countries as a consequence of:

- greater integration of the global economy;

- ongoing technological change;
- increased risk-management ability in developing countries;
- an accentuated dualism between the modern and the subsistence sectors of the economy and in the agricultural sector.

TABLE 4
A schematic typology of financing

	Concessional lending	Grants	Loans on ordinary terms	Private capital
Investment interventions	X		X	X
Policy & institutions	X	X	X	
Capacity building	X	X		
Support services	X	X		
Supervision, monitoring & evaluation	X	X		
Main sources of financing	IDA (World Bank's soft loan widow) IFAD Regional development banks (soft windows) Islamic Development Bank, Kuwait Fund, OPEC Fund Developing country budgets	Bilaterals Trust funds Technical assistance by multilaterals Social development funds HIPC UNDP FAO (technical services/SPFS) WFP (food aid) Other UN agencies GEF (env. problems) GM (for CCD) IFAD (TAGs) Regional banks (for feasibility studies, etc.) CGIAR/IARCs (for research) Arab Funds International NGOs, foundations, Islamic endowment funds Individuals	World Bank (IBRD) / IFC Regional development banks IFAD Islamic Development Bank (leasing; equity participation KFW (Germany)	FDI Portfolio investments through capital markets Commercial bank borrowings Debt restructuring. Trade related deferred payment arrangements, supplier's credits Bonds & shares of developing country institutions in foreign capital markets

The estimates of funds needed for this purpose must be brought within the global framework of financing sustainable development.

Instruments and mechanisms

Flexible lending framework

The Country Poverty Reduction Strategy (CPRS) formulation exercises emphasize improving public resource allocation and raising the productivity and cost-efficiency of public investment. Once there is a consensus on the strategy among the main stakeholders, the World Bank and other donors are prepared to finance the resulting investments through a flexible framework. For example, the World Bank may take the lead in providing broad-based Poverty Reduction Support Credit (PRSC) linked to key objectives, reform areas and priority action areas. Governments will receive the credit on IDA terms in tranches geared to performance. The funding is integrated with the government budgetary cycle and augments the capacity to allocate resources on a cross-sectoral basis. FAO has a role in assisting governments in articulating their agriculture sector strategy and in the formulation of programmes within the CPRS framework. Interested bilateral donors could enter into partnership with FAO to support such programmes.

Improved aid effectiveness needs to complement flexible lending through: improved absorptive capacity in the developing countries: recourse by them to sound and pro-poor policies; and improved aid resource flows to such better performing countries. A logical extension of this process is the common pool approach to assistance. This implies that a single development strategy for each country would guide all donors (each receiving the same monitoring report) with the common pool of resources supplementing the recipient's budgetary resources.

Debt relief

Debt relief covered by the Heavily Indebted Poor Countries (HIPC) initiative can increase resource flows to developing countries. Such relief is tied to appropriate policy reforms. Under the enhanced initiative of 1999, interim debt relief begins immediately at the decision point for most countries. The enhanced initiative has quickened the pace of debt relief. It has the consequence of effectively increasing the resources available to developing countries for agreed priority programmes.

Overall, 41 countries with US$170 billion in external debt are eligible for consideration. Debt owed to multilateral institutions accounted for about 40 percent of their total debt obligations in 1997. From the perspective of such countries, debt relief has a significant impact on their economic prospects. The debt of the average HIPC is more than four times its annual export earnings and well in excess of its GNP. The enhanced initiative seeks to establish a stronger link between debt relief and sustainable poverty reduction programmes in recipient countries. This framework must include support for FAO WFS goals and the SPFS. Of the 23 LIFDCs with the highest prevalence of undernourishment, 17 are in the HIPC group of eligible countries.

Debt relief helps countries access external financial resources by reducing their debt burden and servicing commitments. This should release budgetary resources to meet priority development expenditures. Moreover, debt relief would reduce the preoccupation with negotiating debt service modalities. Instead, it would allow relations with donors to focus on a long-term policy dialogue.

For countries not covered by the HIPC initiative, debt exchange operations could link debt relief to targeted sectoral programmes. The IFAD has some experience in assisting developing countries in negotiating debt transfers linked to Club of Paris debt relief operations. Similar debt transfer arrangements have also been negotiated in the context of debt restructuring or buybacks financed by the IDA and other donors.

Private sector participation in public goods and services

International public goods make an important contribution in sustaining the development process in the developing countries. Specialized technical agencies of the UN system provide public goods in the form of technical assistance, advisory services and international standards. However, as conventional ODA ordinarily flows on a government-to-government basis, the financing of international public

goods has tended to occur on an *ad hoc* basis. Structured funding mechanisms could provide systemic support for international public goods. This would require innovative mechanisms aimed at:

- integrating country-based financing with global and regional programmes;
- leveraging public resources with additional private money;
- a framework to align the incentives of countries with the global public interest through standards, treaties and regulatory mechanisms.

Market distortions, imperfect access to information and uncertainty about cost-benefit relationships have discouraged private sector participation. This area requires capacity building in entrepreneurial skills and facilities for financial services and working capital support. The private sector does not find sufficient incentive to operate in remote rural areas with poor infrastructure. Decentralized financing mechanisms are needed to facilitate service provision, such as extension and micro-credit.

Some national public goods affect the creation of international public goods. For example, planting forests helps reduce gas emissions. However, there is a distinction between the financing of core activities to create public goods and support for complementary activities for their diffusion and use. Both types of activities may involve different types of financing mechanisms and cost recovery or revenue generation modalities. Moreover, there is a real need for innovation to facilitate direct financing of regional cooperation programmes.

The Clean Development Mechanism

Under the CDM, industrial countries could purchase rights to emit greenhouse gases from activities in developing countries. Emission rights trading is intended to ensure that emission reductions occur where they are cheapest to implement. The purpose of the CDM is, in part, to assist developing countries in achieving sustainable development. However, its functioning has raised a number of technical and institutional issues.

The Prototype Carbon Fund

The Prototype Carbon Fund is a private-public partnership (sponsored by the World Bank) to facilitate emission rights transactions between private investors and host countries. Through the monitoring, verification and certification of emission reduction, the fund could build trust between parties and so promote sound development of the market. The fund expects to attract additional public and private resources and promote the transfer of environmentally safe technologies.

Climate change

The first session of the Conference of the Parties (COP 1) of the UNFCC identified three stages in the adaptation process:

- Stage I. Impact studies to identify particularly vulnerable countries or regions. Assessments of policy options for adaptation, and appropriate capacity building.
- Stage II. Measures, including further capacity building, to prepare for adaptation.
- Stage III. Measures to facilitate adaptation, including insurance.

COP 1 decided to fund the full cost of Stage I measures where these are part of the formulation of national communications (extended to Stage II measures in 1998). The Global Environment Facility (GEF) has been financing climate change enabling activities. The UNFCC applies to activities to adapt to climate change. However, the financing mechanisms for these measures are not yet clear.

Joint implementation as a flexible financing framework

Joint implementation originally referred to a generic family of institutional mechanisms that would allow parties to engage in cooperative (bilateral and multilateral) implementation of their commitments. Such assistance could have three components:

- Assist with the implementation of sustainable agricultural development strategies, policies and activities which would also have a positive impact on adaptation to climate change.
- Finance activities which specifically implement adaptation concerns.
- Enable the sale of emission reductions by developing countries.

The Global Environment Facility and the Global Mechanism

The role of the GEF is largely catalytic, providing funding in the form of guarantees, concessional loans and grants. The key features of GEF financing are:

- Financing of incremental costs linked to interventions that address global environmental concerns which otherwise would remain unattended in the national projects. Thus, the GEF helps mobilize substantial cofinancing of resources relating to local/national investments.
- Pursuing global and local linkages with an emphasis on global benefits.
- Promoting market-oriented policies in cooperation with both private and government partners, with an increasing focus on programmatic funding.

The focal areas of the GEF are: biological diversity; climate change; international waters; and ozone layer depletion. The GEF Council has decided in principle that land degradation should become a focal area. It has also made the IFAD one of its executing agencies. This provides an opportunity for closer collaboration between the Global Mechanism (GM), the IFAD and FAO to leverage GEF financing for the design and implementation of investment programmes linked to CCD. The GM is a facilitator for resource mobilization from multiple financing channels, seeking to promote partnerships for financing CCD implementation. In this context, the GM has sought to forge close collaboration with the GEF in:

- facilitating and generating a pipeline of projects and activities for potential GEF financing;
- forging partnerships based on CCD's cross-sectoral and participatory approach to land degradation as an integral part of development strategies;
- facilitating the mobilization of financial resources to cofinance GEF assistance.

The development of a grant facility

Given the debt management problems of many developing countries, a grant facility can provide appropriate financing for many areas of investment, such as capacity building, institutional and policy development, and other public goods and social capital. Many of these countries need extensive capacity building support to implement their poverty reduction and agricultural development strategies. In this context, the establishment of trust funds in the multilateral institutions (funded by bilateral donors) has become an important source of grants (Table 5).

TABLE 5
Donor contributions to trust funds administered by selected international organizations

Organization	Most recent reporting year	Amount (US$ million)	Share of global or regional programmes (%)
UNDP	1999	329.0	20
WHO	1998-1999	93.0	70
UNICEF	1999	601.7	4
Asian Development Bank	1999	135.3	25
Inter-American Development Bank	1999	25.4	80
World Bank	2000	1 301.0	55

CONCLUSION

For many developing countries, investment in land and water resources is crucial to their efforts to achieve food security and sustainable development. Such countries need to attract significantly increased funding. This calls for a fully integrated framework and innovative approaches to facilitate financial flows throughout the developing world, with greater private-sector involvement and an enabling role for governments.

Developing countries, international institutions and donors need to channel investment resources to where they will be most effective in terms of achieving development goals. However, with the limited amount of public and private funding available, the emphasis has to be on a more rigorous prioritization of aid allocations and on the more effective use of aid resources. There is a strong case for including land and water resources as priority areas for ODA allocations within the framework of poverty reduction strategies.

Quantifying investment needs for agricultural development in Asia

PURPOSE OF THIS DOCUMENT

In order to support ***World Food Summit: five years later*** *(WFS: fyl)* and in particular to draw attention to investment needs in agriculture, FAO proposes a method to estimate investment required to accelerate agricultural development in Asia and the Pacific region particularly regarding land and water development and production intensification. This method would enable ministries of agriculture to dialogue more effectively with designated national financial authorities regarding investment requirements for agricultural development. The methodology proposed is straightforward, transparent and adaptable to country circumstances.

Though empirical and still approximate, the advantage of the method over more global approaches is that it enables governments to track relationships between investment in a range of selected items contributing to development (Table 3), and chosen development indicators such as growth, poverty reduction and food security. Attention is thus focused on trying to demonstrate *how* investment in agriculture influences development rather than assuming this the case. The method can be tailored to individual country circumstances and choices by selecting a preferred development goal, by including investment items most likely to influence the goal and by applying country-specific unit costs for each investment item. The method does not prescribe investment items or the source of funding for investment.

The method's greatest value is likely to be that it provides the agricultural sector with an instrument to quantify the likely costs and benefits of investing in the sector. Such quantification – particularly as it becomes more refined with use – should serve to strengthen agriculture's case for greater prominence in policy debates and investment allocation with those who control finances in countries, with donors and with potential investors. Greater insight into the linkages between investment in agriculture and desired development outcomes at country level will hopefully help reverse the downward trend in agricultural investment which seems to have been little influenced by general (though true), statements about the centrality of this sector for growth, development and food security.

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The purpose of this document is thus to present the method to participants for comment, at the same time requesting them to apply it at country level using national costs per item to thereby assist generating more reliable and thus credible global investment figures for Asia. The example used in the document to demonstrate the use of the method estimates agricultural investment needed for the Region as a whole to achieve the WFS objective of halving the number of hungry people by 2015. A range of investment items most likely to affect primary agriculture as well as food processing and distribution are used, and estimated average costs per item are applied.

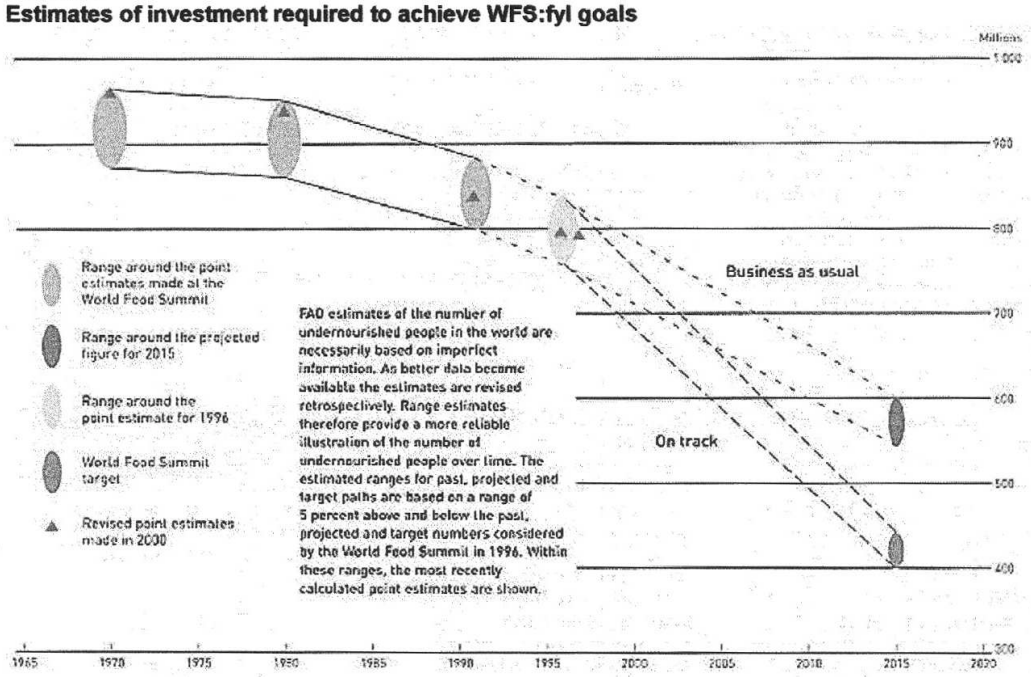
METHOD

Increased demand

It is assumed that ***WFS:fyl***, is inspired, at least in part, by the need to improve the effectiveness of efforts to achieve the goals of the WFS, particularly to reduce the number of hungry by half by 2015.

Since the purpose of the exercise is to develop scenarios for country specific investment in land and water development, and production intensification, additional food needs have to be quantified before possible investments to meet these increased needs can be established under various assumptions. The purpose of the exercise is thus to estimate investment required to generate incremental production needed to meet the WFS goal by 2015 as illustrated in the 'on track' projection in the following diagram.

FIGURE 1
Estimates of investment required to achieve WFS:fyl goals



Source: The state of food insecurity in the world 2000, FAO

SOURCE: The state of food insecurity in the world 2000, FAO

TABLE 1
Food production increments required by 2015 (%)

	CEREALS	OTHER FOOD	LIVESTOCK	TOTAL FOOD
Bangladesh	**29**	**27**	**27**	**28**
India	**6**	**5**	**6**	**5**
Nepal	**12**	**9**	**13**	**11**
Pakistan	**13**	**13**	**33**	**25**
Sri Lanka	**7**	**3**	**6**	**5**
Cambodia	**6**	**6**	**17**	**9**
China	**28**	**10**	**12**	**15**
Indonesia	**7**	**6**	**-**	**1**
DPR Korea	**22**	**32**	**39**	**26**
Lao PDR	**29**	**27**	**36**	**30**
Malaysia	**6**	**13**	**10**	**11**
Mongolia	**13**	**17**	**23**	**22**
Myanmar	**5**	**13**	**-**	**5**
Philippines	**16**	**12**	**26**	**18**
RO Korea	**5**	**2**	**-**	**-**
Taiwan	**11**	**14**	**32**	**23**
Thailand	**2**	**-**	**7**	**-**
Viet Nam	**7**	**3**	**19**	**9**

The anticipated additional demand for food is expressed by FAO in a revised per capita kcal food intake for each country that would achieve the goal of halving the number of undernourished people – assuming that the WFS target applies to each country and that the per capita calorie consumption pattern remains the same as the base year (1995/1997). The Agriculture Towards 2015/30 scenario is based on the UN 1998 Assessment for population projections and on FAOSTAT data as known in June 1999. It is currently being revised for the final AT2015/30 report. The enhanced daily per capita calorie food intake is distributed proportionately over the 28 food commodities that constitute the FAO AT 2015/30food basket; i.e. no change in the composition of the food basket is assumed. Additional per capita calorie intake is thus converted into volume of food items by allocating additional calorie demand proportionately to the food items in the 2015/30-food basket. This additional demand or enhanced daily per capita calorie food intake (consumption) multiplied by projected population size provides the anticipated increased demand for food at national level.

Increased domestic production

The need for increased domestic production is arrived at by subtracting FAOs latest estimates of likely food supply in 2015[1] from the anticipated increased demand for food. The portion of the

[1]Estimates of food supply in 2015 are presented in *Agriculture Towards 2015/30*, Technical Interim report, April 2000. However, data used by FAO are subject to continuous revision and only country specific information provided by countries can lead to greater accuracy. The estimates are in particular sensitive to population growth and the estimate used for daily per capita calorie food intake.

increased demand to come from increased domestic production is established by maintaining the projected AT 2015/30 Self-Sufficiency Ratios (SSR) constant. Doing this assumes that net imports of foodstuffs will increase at the same rate as domestic production.

TABLE 2
WFS 2015 added land requirements ('000 ha, base AT2015)

COUNTRY	RAINFED	IRRIGATED
Bangladesh	-	667
India	-	1 870
Nepal	-	51
Pakistan	314	755
Sri Lanka	15	0
Cambodia	95	9
China	237	-
Indonesia	701	403
DPR Korea	29	123
Lao PDR	118	6
Malaysia	112	-
Mongolia	0	0
Myanmar	-	-
Philippines	829	170
Republic of Korea	47	92
Taiwan	0	0
Thailand	-	174

Increased production requirement to achieve the WFS goal for countries and commodity groups expressed as a percentage of the projected AT 2015/30 year 2015 production is presented in Table 1. The increased production requirements itself vary, however, according to country specific planning assumptions and is not presented here. In addition, ongoing policy and investment interventions, likely to have a substantial impact on eventual domestic production are not considered. It would appear that increased production to achieve the established goal, under the assumptions made, is substantial in most countries.

Yield increases and harvested land expansion

Increased harvested area (rainfed and irrigated) and higher yields provide the required increase in production by country. The AT 2015 Crop Growth Factors (yield increases and harvested land expansion) for each of the 34 crops under the 'business as usual scenario' were used. Major efforts will also be required under the assumptions made to expand irrigated agriculture. Increased yields will also need to be supported by increased fertilizer inputs. Fertilizer use in the region is low; however, farmers can only achieve higher 'national' yields when fertilizer use becomes more profitable. This implies that increased demand for food becomes effective, that increased food supply originates primarily from domestic production and that improved fertilizer response, for which investment in soil

fertility is a prerequisite, materialises. Increased fertilizer use to support the higher yields was estimated using the procedures described in *Fertilizer Requirements in 2015 and 2030, FAO 2000.*

Investment

To relate increased production to investment, 27 capital items contributing to agricultural production, developed by FAO, are proposed. These cover resource and input requirements for primary agriculture, marketing and processing facilities and include other elements of rural development such as infrastructure. No direct provision has been made for investment in technology development and transfer because of the difficulty of establishing a basis to estimate this for Africa as a whole. Individual countries may thus choose to add research and extension as a capital item contributing to agricultural development. When countries complete their cost table (Table 3), the compilation of the investment cost is straightforward (Table 4). A provisional indication of the magnitude of the required investment in land and water development as a percentage of the total investment in the primary sector (crop and livestock production) is presented in Table 5. It is again emphasized that these results come from indicative investment costs expressed in calibrated 1994 US dollars while some investment items have not been included at all due to lack of data. This points to the need for countries to use the best information at their disposal when completing Table 3 to ensure a meaningful outcome.

TABLE 3
Provisional average investment unit costs in 1994 US$

INVESTMENT ITEM	DESCRIPTION	Average Unit Cost		
		US$	East Asia	South Asia
1. Development of arable land under crops	Estimated separately for six land classes, each valued at its specific unit cost. Total unit cost shown is weighted average. No depreciation.	($/ha)	350	350
	• Rainfed land: low rainfall	($/ha)	0	350
	• Rainfed land: uncertain rainfall	($/ha)	350	350
	• Rainfed land: good rainfall	($/ha)	350	350
	• Rainfed land: problem areas	($/ha)	350	350
	• Naturally flooded land	($/ha)	350	350
	• (Irrigated) desert land	($/ha)	0	350
2. Irrigation extension & improvement	Unit costs are region-specific. Unit cost show is weighted average. Depreciation rate is 2.4% per annum	($/ha)	2 750	2 750
3. Soil & water conservation	25%of all non-irrigated land to be protected by 2015 (up from 0.0% in 1988/1990. No depreciation.	($/ha)	150	150
4. Flood control	20 to 60% (depending on region) of all naturally flooded land to be protected by 2015 (up from 10-30% in 1988/1990. Depreciation 2% per annum.	($/ha)	800	800
5. Establishment of permanent crops	Costs incurred from planting to bearing for citrus, other fruit, oil crops	($/ha)	2 500	2 500
6. Tractors & equipment	Standard units include 1 45 hp 4-wheel tractor 3-bottom mouldboard plough, tandem disk harrow seed box trailer & (Near East only) 1 combine harvester per seven units. Unit cost shown is weighted average. Depreciation:12.5% per annum.	($/ tractor)	25 000	25 000
7. Increased numbers of draft animals	Animal pairs; no depreciation.	($/pair)	800	800
8. Equipment for draft animals	Standard set of plough harrow, seeding tube, 2-wheel cart. Depreciation rate 10% per annum.	($/set)	300	300
9. Handtools	$17.60 per member of agricultural lab worker. Depreciation rate 20% per annum.	($/set)	25	25
10. Working capital	50% of the increased fertilizer nutrient cost taken as investment in working capital.	-	300	300

LIVESTOCK				
11. Increased number of livestock	Number of animals added to existing stock, Each animal is valued at the product of its carcass weight & meat price (2 023, 2 032, 1 366 & 1 300 $/metric tonne respectively)			
	• Cattle & buffaloes	Each	200	200
	• Sheep & goats	Each	80	80
	• Pigs	Each	100	100
	• Poultry	Each	1	1
12. Milk production	Two-thirds increased milk production assumed from projects needing investment of $528/tonne. Depreciation unknown. On-farm share assumed at 10%	$/mt	700	700
13. Housing, equipment for commercial pig & poultry production	Sows are 15% of commercial pig operations. Pig operations to grow to 60% in 2010 (20% in 1989**); poultry to 70% (30% in 1989**). Depreciation 5% per annum.			
	Sow units	$/unit	1 300	1 300
	Birds	$/bird	1	1
14. Development of grazing land	Land clearance & establishment of watering points.	$/ha	80	80
15. Meat production	Two-thirds added meat production assumed from projects with investment of 7 040 $/tonne. No depreciation could be identified.	$/mt	4 000	4 000
16. Milk production	Same rules as for item 12; Off-farm share assumed at 90%	$/mt	700	700
STORAGE, MARKETING & PROCESSING				
17. Dry storage	All increments in production to be stored at investment cost from $20/mt at farm level to $300/mt for upright silos. Crops: cereals, pulses, oilseeds, cocoa, coffee, tea, tobacco, cotton, sugar. Depreciation 2% per annum.	$/mt	130	130
18. Cold storage of bananas, fruits & vegetables	1% of production to pass through cold storage; allowance for cold storage of livestock products in included in items 12, 13 & 16. Depreciation 14.3% per annum.	$/mt	2 700	2 700
19. Rural marketing	25% of agricultural population to be served by 2010 (20% in 1989**). Depreciation 2% per annum.	000$ /unit	300	300
20. Assembly & wholesale markets for fruits & vegetables	From 30 to 70% of production (depending on region)to be handled in such markets. Depreciation 2% per annum.	$/mt	300	300
	Vegetables	$/mt	1 601	1 141
	Bananas, citrus and other fruits	$/mt	1 569	1 122
21. Transport of agricultural products	40% of all products assumed transported an average 200km	$/mt	200	200
22. Milling cereals	All cereals used for food plus 25% of feed cereals milled locally. Depreciation rate 5% per annum.	$/mt	120	120
	Wheat	$/mt	260	260
	Rice	$/mt	100	100
	Maize	$/mt	150	150
	Barley	$/mt	150	150
	Millet	$/mt	150	150
	Sorghum	$/mt	150	150
	Other cereals	$/mt	150	150
23. Processing oilseeds	80-85% of all oilseeds crushed locally. Depreciation 8% per annum.	$/mt	180	180
24. Processing sugar crops	Cane & beet production (net of feed, seed) processed into raw sugar. Depreciation 6% per annum.	$/mt	2 300	2 300
25. Processing fruits & vegetables	1-2% processed for domestic use; about 12% of 1989** exports processed increasing at 6% per annum. Depreciation 8% per annum.	$/mt	1 000	1 000
26. Ginning of seed cotton	All seed cotton ginned domestically. Depreciation 5% per annum.	$/mt	100	100

NOTE: * mt = metric tonne; ** Stoutjesdijck, November 1994 (1992 US$);

TABLE 4
Net Investment requirements US$ million (1994)

	LAND & WATER	CROP PRODUCTION	PERCENTAGE
Bangladesh	1 503	9 433	16
India	3 328	22 925	15
Nepal	139	509	27
Pakistan	2 198	12 762	17
Sri Lanka	5	325	2
Cambodia	61	104	58
Indonesia	1 381	3 325	42
DPR Korea	349	1 647	21
Lao PDR	63	121	52
Malaysia	-	2 124	-
Mongolia	0	43	0
Philippines	790	3 275	24
RO Korea	271	321	84
Taiwan	-	18	-
Viet Nam	279	6 704	4

Investing in irrigation and drainage in the context of water policy and institutional reform

INTRODUCTION

Participatory irrigation management and irrigation management transfer reforms often have the stated objectives of providing sustainable and adequate financing for operation and maintenance of irrigation and drainage services and of facilitating investment in the required rehabilitation or upgrading of irrigation systems.

Overall reform of water resources management often encompasses these reforms. It often includes demand management to encourage efficient water allocation and imposes new externalities on irrigation systems in terms of environmental performance.

In Asia, where older public schemes reach the age of 30 to 40 years in most countries, the issue of rehabilitation, which is related to those of operation and maintenance and modernization, is becoming increasingly important. While for some countries the extension of irrigated land still represents an important part of irrigation programmes, in most countries rehabilitation programmes are taking on increasing importance. The content and orientation of rehabilitation in a context of PIM/IMT will therefore be critical.

This paper reviews the concepts of irrigation management transfer, modernization and service. The paper then examines IMT and PIM in the context of reforms towards integrated water resources management. It is important to understand the actual characteristics and water management in the systems that are being transferred. Thus, the paper reviews the actual systems as they exist and impact and results of IMT and PIM programmes in the region and focuses more particularly on water management for rice, which is the most important crop in the region. The paper then expands on the notion and consequences of service orientation in irrigation and drainage, and examines requirements in training and capacity building in the sector.

In the conclusion, some general findings and recommendations are made on investment in irrigation and drainage systems in the context of water policy and institutional reform.

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In two separate annexes, the decline in public investment in the sector and the relation between irrigation and drainage development and poverty alleviation are discussed. Poverty alleviation is increasingly the overarching socio-economic development goal of countries and donors.

SOME DEFINITIONS

Irrigation management transfer and modernization

Irrigation management transfer (IMT) can be defined as the turning over of authority and responsibility to manage irrigation systems from government agencies to water user associations. This involves two key roles: the authority to define what the irrigation services will be and the authority to arrange for the provision of those services. After IMT, the water users, typically organized into a water users association (WUA) decide what services should be provided, what their objectives and target should be, what service performance standards are acceptable. Arranging for the provision of those services includes choosing service providers and collecting whatever resources are required to implement the desired services.

Modernization of an irrigation system could be defined as the act of upgrading or improving the system capacity to enable it to respond appropriately to the water service demands of the current times, keeping in perspective future needs, or as a process of technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation schemes with the objective to improve resource utilization (labour, water, economics, environmental) and water delivery service to farms. The process involves institutional, organizational and technological changes. It implies changes at all operational levels of irrigation schemes from water supply and conveyance to the farm level. The objective is to improve irrigation services to farmers although improvements in canal operation will generally be a critical first step in the process. It is they who have to take the final decisions on the modernization programmes and improvements should not stop at the canal level.

Modernization thus defined assumes that IMT has taken place and that farmers are in a position to decided on the level of service they want and are willing to pay for. The term “modernization” refers therefore not only to the rehabilitation, upgrading or transformation of physical infrastructure in irrigation systems but also to innovation or transformation in how irrigation systems are operated and managed.

IMT programmes commonly include efforts to rehabilitate, upgrade or modify irrigation infrastructure. They also often include efforts to introduce new management systems or procedures that are consistent with the expectations and constraints which result from IMT, such as service agreements, management audits, asset management and information systems. In the context of IMT, modernization is related to the process of transformation from supply-driven to service-oriented water delivery and to changes in governance of the systems for goal setting, which includes the decision on the service to be provided by the system.

There is a general acceptance of the principle that water management institutions should be consistent with hydraulic management units, either at the basin, system levels or within the systems, and in practice the configuration of the irrigation systems has had a great influence on the design on PIM/IMT programmes. Other important linkages are related to the setting of objectives for the irrigation systems. Relevant to IMT would be among others the determination of cropping patterns by a previously top-down institution and of the service to be delivered to farmers and on the other hand the necessity to manage water supply and drainage effluents in a river basin/integrated water resources management perspective rather than for the single purpose of irrigating crops.

Service

The notions of water delivery service and of generalized service-orientation of institutions in the irrigation sector, whether river basin agencies, reformed irrigation agencies, irrigation service providers or water users associations has become central in new concepts and definitions of participatory irrigation management and irrigation management transfer. Literature on the evaluation of impacts of on-going participatory irrigation management and irrigation management transfer programmes in terms of water service delivery, agricultural productivity and agricultural performance indicates that improved service is a problem area. The sustainability of the water users associations is however now seen to depend on their capacity to provide an adequate water delivery service and control and to allocate water and to provide an improved service to enable gains in agricultural productivity. This is essential for the capacity of farmers to pay water and for the water users associations to be financially viable. As a result, it is now recommended that strategies of gradual improvement of irrigation systems be adopted to support the transfer of water management responsibilities and associated rights.

The concept of irrigation service was introduced in the 1980s together with methods to evaluate service quality. Service is not an abstract or generic notion: it can be qualified precisely in terms of equity, reliability and flexibility as well as adequacy. The degree of flexibility in frequency, rate, duration is what distinguishes and characterizes classes of service quality from rotation to on-demand. Thus, the decision on the flexibility at all levels and ultimately at the farm is the most important decision as regards service. Flexibility is most closely related to improvements in agricultural performance, crop diversification, etc. The service definition will also specify the responsibilities of all parties (farmers, Water User Associations (WUAs), operators of the tertiary canal, operators of the secondary canals, operators of the main canals, and project authorities) in operating and maintaining all elements of the system. A main canal provides water, with a certain level of service, to secondary canals. Each upstream layer in a hydraulic distribution system provides service to the layer immediately downstream of it. The actual levels of service at each layer must be examined to understand the constraints behind the level of service that is provided to the field.

There is a wide range of levels of irrigation service, and the nature of the service may vary significantly from a highly flexible service differentiated at the farm level to an inflexible service provided on an undifferentiated basis to a large number of farmers. It is therefore important to qualify the level of service. The levels of service may be different at each layer. It is also important not only to identify what the existing level of service is, but also what the expectations are at each layer of operation. In service-oriented water management, the decision on the level of service against the cost for providing this service, from ISP to WUAs and WUAs to users, is expressed through service agreements which are the foundation of an asset management strategy and managerial capacity upgrading programmes which are translated into financial plans. Service agreements may be a modality to force a negotiation on service levels and initiate a process towards a transformation of top-down irrigation agencies by providing accountability and transparency.

PIM/IMT, MODERNIZATION AND INTEGRATED WATER RESOURCES MANAGEMENT

Irrigation sector reform and water sector reform

Participatory irrigation management lies squarely within an integrated water resources management perspective and the policy and institutional changes that this new perspective demands. The growing understanding of the centrality of water rights and water allocation issues reinforces this integration. Clearer water rights and farmer participation in basin water resources management to facilitate more equitable, more efficient processes to improve water use efficiency and reallocate water among users become an important issue. The question of the restructuring and reorientation of the existing

irrigation agencies towards assuming responsibilities in implementing water resources management further strengthen these linkages.

Box 1
Possible new roles for irrigation agencies

- River basin planning
- Water resources allocation & monitoring
- Development of new policies and regulations
- Environmental monitoring and enforcement
- Groundwater monitoring and control
- Project planning, design and construction
- Technology transfer to IA
- Advisory services to associations
- Monitoring of association performance
- Arbitrating disputes

The need for a long-term vision

Integrated water resources management is a continuing process that needs to be integrated into economic development processes. In this context, it is necessary to have a long-term vision of integrated water resources management and of the transformations that will be required in each sector.

For this purpose, the validity of strategic planning approaches to identify actions that need to be taken by each actor in each sector by redefining missions, goals, objectives, strategies and priority plans for immediate action has been tested by FAO and ESCAP in four countries in the region: Malaysia, Philippines, Thailand and Viet Nam in 2000. This exercise was coordinated with the global, regional and national visioning processes animated by the World Water Council and Global Water Partnership in preparation of and as a follow-up to the Second World Water Forum at the Hague, 2000. This international initiate was taken with the objective of averting the looming water crisis and foster immediate concerted action. At national round tables in 2001, four countries reconfirmed their national water visions (Box 2).

Considering the national vision and specific considerations of food security, agricultural and rural development, the countries have defined sectoral visions that encapsulated integrated water resources management goals and developed priority action plans. Significantly, irrigation management transfer and participatory irrigation management were high on the agenda in each country. By applying strategic planning approaches to the irrigation sector, Viet Nam and the Philippines found that mere rehabilitation of irrigation infrastructure would not be sufficient to achieve the vision and that the pilot introduction of modern water control and management concepts was identified among the main priority actions. Modernization of irrigation systems is already an integral part of Malaysia's water resources management strategies and is one of the measures being studied at present in Thailand.

The study has shown that in practice several important issues need to be considered while one analyzes organizational change for participatory irrigation management:

- Arrangements will need to take into account water rights and allocations in a river basin perspective;

- Modernization of irrigation systems can be understood as the combination of water management strategies and related institutional and technical solutions;
- An integrated water resources management perspective, even in the long term, requires changes now.

Box 2
National Water Visions

Malaysia

In support of Vision 2020 (towards achieving developed nation status), Malaysia will conserve and manage its water resources to ensure adequate and safe water for all (including the environment).

Philippines

By the year 2025, water resources in the Philippines are being used efficiently, allocated equitably and managed sustainably with provisions for water-related disasters.

Thailand

By the year 2025, Thailand will have sufficient water of good quality for all users through an efficient management, organizational and legal system that would ensure equitable and sustainable utilization of its water resources with due consideration on the quality of life and the participation of all stakeholders.

Viet Nam

The Viet Namese Water Vision is the integrated and sustainable use of water resources, the effective prevention and mitigation of harms caused by water for a better future on water, life and the environment.

Environmental externalities

Historically, modifications to irrigation projects have not given thorough consideration to environmental consequences. But scarce water and concern for environmental impacts increase the need for improved on-farm irrigation management. Low irrigation efficiencies have been documented in various projects, and improved irrigation efficiencies are often listed as a major source of "new" water. However, it is now evident that return flows from an "inefficient" project are often the supply for downstream projects, in the form of surface flows or groundwater recharge. Therefore, typical project irrigation efficiencies in the 20 to 30 percent range by themselves give no indication of the amount of conservable water within a hydrological basin unless that project is at the tail end of the basin. Conservation (i.e. less spill, deep percolation, and seepage) within one project may deprive a downstream project of part of its accustomed water supply.

Most 'new' water for existing basins and projects will only appear if there is improved irrigation water manageability by farmers. The potential sophistication of on-farm water management is highly dependent upon the level of water delivery service provided to individual fields, which in turn depends upon the conveyance manageability within the complete water distribution system.

Box 3

Methods that yield "new" water

1. Improved Water Use Efficiency (WUE), where WUE is defined as

$$WUE = \frac{\text{Crop Yield}}{\text{Irrigation Water Consumed}}$$

Improved WUE can come from improved use of rainfall, improved timing of irrigations to match critical stages of crop growth, improved investment in fertilizers, pesticides, and cultural practices, reduced waterlogging.

2. Improvements in the quality of surface return flows.

3. Reduction of deep percolation from farmer fields, and the associated reduction of nitrate leaching.

4. Reduction of on-field deep percolation destined for a salt sink.

The critical importance of maintaining minimum flow rates and water qualities in natural drains and rivers is increasingly being understood. In the USA and Europe, for example, many recent irrigation system modernization efforts have stemmed from the need to reduce in-stream damage to endangered species of fish. In Malaysia, modernization strategies also incorporate similar environmental objectives for rivers. The quantities and timing of river diversions, and qualities and quantities of irrigation return flows, have a tremendous impact on the environment. Increasingly the issues will have to be explicitly dealt with by irrigation systems and farmers in the region. This is already the case in some of the most economically developed countries, and will be a future requirement in other countries, which must be anticipated now.

IRRIGATION SYSTEMS IN ASIA

The actual irrigation systems

The concepts used for the development of irrigation by colonial powers were adapted to the conditions and to the objectives of irrigation in the past. Irrigation was extensive and the water resources were not regulated by large storage reservoirs. The design standards adopted in many developed and developing countries after the mid-1900s to deliver water according to crop demand were conceptually more advanced. However most of them fail to meet that objective because of the deficiencies of the water control technology and complexity of the operational procedures. Managing an irrigation system equipped with manually-operated gates at each branching point is a very complex task. In many cases, the systems were designed to be operated at full capacity without consideration for operation at less than full supply. The use of technology with continually adjustable structures which has been the norm during the three decades of intensive development of irrigation in developing countries from 1960 to 1990 has badly affected the performance of irrigated agriculture in many countries. Even the best qualified managers and operators would not be able to manage these systems to the highest standards. They simply cannot work. They are now impeding the transfer of management to user associations. They are being successfully automated in western countries but not in developing countries.

The farmers served by these systems responded to the economic changes and poor performance or inadequate service by tapping additional water resources to overcome the limitations of the existing systems, which were under sized for intensive irrigation such as the typical structured design systems or provided erratic water supply, to be able to adopt modern cultivation practices and diversified cropping patterns: tampering of control structures, pumping from canals, drains, borrow pits, replacing animal-driven pumps by motor-pumps and more recently tapping groundwater resources with a dense system of shallow wells or deep tubewells which provide the flexibility and reliability needed for modern irrigation at farm level. These responses from the farmers are inevitable.

If the water distribution rules define a pattern of water distribution that does not match technically feasible and desired goals of the water users, the users will subvert these rules. This will lead to poor water delivery performance and increases in the cost of irrigation to users. Inconsistency in the water distribution rules creates difficulties in system operations that are likely to lead to inefficient and inequitable water distribution performance. Especially inconsistency of rules between various levels: reservoir, main canal, channels is detrimental. Rules in channels cannot be followed if there is unpredictability of delivery by main canal.

Making water delivery match goals is important. The need for change in response to changing environment, changing agriculture, diversification, etc. requires adapting water distribution rules to changing demands. The users, on the other hand, must accept the limitations on uses imposed by water availability and the features of the system. These considerations call for a greater attention to an analysis of operational rules at all levels in the system and particularly to a proper articulation of operational rules at the interface between the future irrigation service providers and water user associations, to the necessity of improving operations in the upper levels of management if water users associations are to be in a position to develop applicable rules and procedures, and to the necessity of incorporating at all levels production objectives of the farmers.

Very few countries have adopted the full spectrum of modern irrigation concepts and standards. In a few cases, the design makes use of the most advanced technologies for water control but the water distribution strategy lacks the flexibility required for a service oriented delivery. In other cases, the technology is inadequate to satisfy the stated objective of modern irrigation. More frequently, neither the technology nor the strategy meets the definition of service orientation, including the projects with faulty designs, and operational procedures designed for the convenience of the operators, not of the users.

Initial system designs may represent a severe constraint to the adoption of new and more flexible operational procedures. Many problems related to inequity and unreliability of water service can be attributed to design and operational procedures, which, if left unchanged, will produce the same results whatever the governance setup. The question whether the technical/hydraulic dimension of irrigation can be brought under the control of agents focused on non-technical user-derived objectives is central as is this would characterize a service-oriented management. The case for reassessing the design standards, configuration and operational procedures at the moment of transfer as a result of a review or resetting of both internal objectives in terms of service with the water users and external objectives with water resources management institutions is therefore compelling.

An appraisal of initial conditions and performance of the systems to be transfer would allow both a better design and strategic planning of physical improvements together with a definition of the service to be provided both by the irrigation service provider to WUAs and by WUAs to their members, with indications on ways and means to achieve these service goals and improve them in the future, given the forces of change that effect the irrigated sector. To meet the conditions of the future, water delivery from irrigation projects should be more flexible and reliable. Operation rules should be transparent and understood by the users. As for requirements on system operations resulting from

integrated water resources management, water rights and the necessity to satisfy different water uses with same primary infrastructure are not the only issue. Water obligations related to disposal and quality of effluents, other environmental requirements are or will be part of the externalities imposed on system managers in all countries.

Groundwater and IMT

In many parts of the world, groundwater is a major emerging problem. In some areas, overexploitation is posing a major threat to the environment, health and food security. The explosion of groundwater irrigation in some countries is a farmer response to the lack of flexibility and, in the worst cases, the unreliability of the canal irrigation systems. Water recycling and the conjunctive use of groundwater mostly happen as a desperate response from farmers who are unable to obtain their share of irrigation water from the canal or from systems managers as a way to rectify problems of management capacity and shortcomings of the original design. The benefits that the changes have brought to farmers include increased quantity of water, increased reliability of water and freedom for the families to choose their own crop strategies. Service requirements of the farmers are thus met, where possible, from other sources than the delivery of the main surface systems.

It is therefore perplexing that, in spite of an affirmed service orientation, IMT or PIM programmes often fail to take into account actual the service needs as expressed by farmers' actual practices and actual water management in the systems. New institutions appear to reflect the stated operations of the canal systems and not appear the need for combined management of water delivery, drainage, water recycling and conjunctive use. Whether this is a threat to the viability of the water users associations should perhaps be given more attention.

On-farm irrigation technology

The slow adoption of new on-farm irrigation technology is a perplexing issue. A principal reason is perhaps that the focus of attention in developing countries has occurred at the farm level, and not at the level of operation of the main and conveyance systems. Farmers will not invest in water saving technologies if the service of water is not reliable and if the incentives for saving on water, energy and labour are not strong enough. Many important management objectives can only be satisfactorily realized if the main water distribution system is well operated, and only then high returns can be obtained from agricultural extension advice and the increased application of other complementary inputs.

Rehabilitation and upgrading

What are the practices through which physical works are planned in PIM/IMT programmes? Particularly in Asia, the most common planning tool is the walk-through. Lack of farmer participation in design and construction has been identified as a problem area and design processes are meant to be more demand-driven. The objective is to improve conveyance and reliability and reduce canal maintenance requirements (drop structures, etc.). PRA mapping, transects, of land tenure, farming systems, ecosystems are also tools used on the field, mostly to prepare canal layout designs and identify objectives of rehabilitation/improvement. In practice, a diagnosis of operation procedures is not performed and operational rules and procedures are not really discussed or linked to identified works. Physical works are not related to service or performance goals. As a rule, expectations are low. The initial focus on upgrading is generally on reliability and equity, which are admittedly the first issues to address but there is generally no vision of future requirements. There is no discussion of flexibility, i.e. there is no discussion of the main aspect of service quality.

There is still a significant knowledge gap on the impact of IMT and PIM in general. However results of recent impact evaluations and efforts to synthesize existing literature allow us to draw some general conclusions on the impact of PIM/IMT programmes on the quality of water delivery service. However, as most of these programmes have included some measure of rehabilitation or upgrading or infrastructure or on-farm infrastructure development, it is often difficult to separate farmers' involvement benefits from other changes such as rehabilitation.

Quality of operations and maintenance is often a stated goal of programmes, but most of the evidence is qualitative statements. General impression is that after turnover, services have substantially improved in regard to timeliness, reliability, and equity.. Increases in irrigated area and crop intensity are mentioned in many instances. Flexibility is not a service characteristic explicitly investigated but some results in terms of timeliness and adequacy are registered. Improvements in terms of water use efficiency are more uncertain.

In Asia, impacts are typically not noticeable in terms of agricultural performance: change in irrigated area, crop patterns, cropping intensity or yields, PIM has neither improved nor interfered with agricultural productivity. The future of farming is seen to depend on diversification of crops and a more commercial orientation. Diversification makes irrigation management more complex. Irrigation systems may not have enough capacity to deliver water for other crops or irrigation practices or may need to be operated differently. Greater reliability may be required, through improved main system operation or through more flexibility for farmers to locally distribute water according to their needs. The necessity of reengineering irrigation, i.e. taking a fresh look at key processes and how they can best be carried out and of considering both hardware and software elements is emphasized as irrigation becomes more commercial but is in apparent sharp contrast with design processes and their outcomes.

PIM has generally led to modest efforts by farmers to improve management efficiencies and responsiveness. Significant future expenditures loom in the future unless observed under-investment in O&M is halted. It is therefore recommended to replace periodic rehabilitation with ongoing infrastructure improvements jointly financed by government and the farmers, with the objective to improve performance and ensure financial viability and physical sustainability of irrigation. An issue for the sustained success of participatory irrigation management is therefore the availability of financial instruments that allow farmers to invest in the upgrading of their irrigation systems. Decentralized irrigation improvement funds are increasing proposed in IMT programmes. Required support services could be: assessment of system facilities, credit, and design and construction assistance. The assessment can be done jointly by agency and WUA or contracted out: annual maintenance planning, selective improvement, planning whole-system rehabilitation.

Low productivity is also often associated with small farm size, a subsistence orientation, production of low value crops such as grains, inappropriate agricultural policies, a poor natural resource base, and inadequate agricultural services. It is necessary to address these issues or provide assistance through other agencies for production increase, or to subsidize the association. For farmers, the second-generation IMT problem is to increase farm productivity to pay higher irrigation fees and to take advantage of possible improvement in irrigation service quality.

Type of investment projects

Lending for irrigation has progressively changed over time from a project-specific nature of investments to take the form of sector loans or national/regional in scope projects supporting the objectives of participation and capacity building. These projects often combine a mix of low cost rehabilitation projects and management reforms with attention to improved operation and maintenance and user participation. Low cost rehabilitation of irrigation infrastructure, in some cases an investment to catch up years of differed maintenance, cannot correct the deficiencies of the original design, if the causes of deficiencies are not identified through an in-depth diagnosis of the current system. In Asia, where the older public schemes reach the age of 30 to 40 years in most countries, the issue of rehabilitation is becoming increasingly important. In theory, rehabilitation provide an opportunity to take into account the management patterns of operators and irrigators. In practice, however, rehabilitation simply re-establishes the physical configuration of the original system. The content and orientation of rehabilitation in a context of PIM/IMT will therefore be critical.

Towards gradual improvement strategies

PIM has generally led to modest efforts by farmers to improve management efficiency and responsiveness. Under-investment in O&M is also observed. It is therefore recommended to replace periodic rehabilitation with gradual on-going infrastructure improvements, with the objective to improve performance and ensure financial viability and physical sustainability of irrigation. Financial instruments that allow farmers to invest in the upgrading of their irrigation systems become critical. Decentralized irrigation improvement funds to provide matching funds from Government are increasing proposed in IMT programmes.

Other regions have often adopted a radically different approach

In contrast with this model, IMT in other regions has often taken a very different shape, with a deliberate effort to change the control logic of the systems from the top down and the transfer of large units of the systems to large water users associations. IMT has been more engineering driven, and this is the main difference with Mexican, Turkish and US experience. The issue is whether basic flaws or constraints can be addressed with a light rehabilitation programme and whether not doing so hampers IMT/PIM or jeopardizes the success of reform in terms of sustainability of institutions and financial sustainability.

Toward new forms of IMT

WUAs as business enterprises are increasingly seen as a potential solution in the region, perhaps as a reflection of Latin American experience, and the question whether they might deliver other services to farmers is important in the debate on PIM reform. The formation of pilot farmer companies in two systems in Sri Lanka represents a paradigm shift, from PIM as joint management to the formation of the farmer company: agribusiness development and irrigation management turnover, in open-market economy, with irrigation more than a subsector of agriculture, but seen in tandem with trade, commerce and industry. Water is seen as a commodity and no more tied to land and is transferable.

The farmer company is the institutional mechanism for commercialization of farm operations. Distributary canal organizations will continue to function for water management and O&M. Resources allocated by government for O&M will be advanced to the company which will have four divisions: irrigation, primary production, commercial, finance and administration. The irrigation division will be responsible after transfer of management of the system and provide water rights based on land entitlement.

PIM in Sri Lanka has failed to have results in terms of O&M, water management or productivity, so to implement participation systematically, organizations need a critical mass of mutually reinforcing practices, a participative system with an eye on the product and market. It is therefore necessary to shift the focus of PIM to agriculture as an enterprise resulting in a phased turnover of the irrigation system in totality. New suggested management strategies are significant (conjunctive use, etc.). It is suggested that this pilot experience may be a laboratory for larger Asian countries.

Second-generation problems: required services to water users associations and farmers

Among the major second-generation problems for associations, the most significant are: insecure water rights, financial shortfalls, rehabilitation and the lack of financial and administrative management expertise

For farmers, the second-generation problem is to increase farm productivity to pay higher irrigation fees and to take advantage of possible improvement in irrigation service quality: production credit; extension service; new technologies; markets and market information; access to inputs; post-harvest services

All irrigation systems require periodic rehabilitation and modernization. If WUAs defer rehabilitation, they will also not upgrade the systems. Many authors suggest that sharing costs of rehabilitation is appropriate. Required support services to water users associations would be the assessment of system facilities and credit and design and construction assistance.

Assessments may be done jointly by the individual agency and WUA or contracted out: annual maintenance planning; selective improvement; and planning whole-system rehabilitation. Assistance in selection and supervision of consultants and contractors can be facilitated at the level of the federation of WUAs to individual WUAs.

RICE

Rice in Asia

In most of Asia, rice is not only the staple food, but also constitutes the major economic activity and a key source of employment and income for the rural population. Water is the single most important component of sustainable rice production, especially in the traditional rice-growing areas of the region. Reduced investments in irrigation infrastructure, increased competition for water and large water withdrawals from underground water lower the sustainability of rice production. However, despite the constraints of water scarcity, rice production must rise dramatically over the next generation to meet the food needs of Asia's poor. By year 2025, rice production in Asia must increase by 67 percent from the 1995 production level in order to meet the increased demand for this cereal which is the staple for more than one-half of world's population. Producing more rice with less water is therefore a formidable challenge for the food, economic, social and water security of the region.

About 80 to 90 percent of all freshwater resources used are for agricultural purposes and more than 80 percent of this water is used in irrigating rice. In other words, the efficiency of water use in irrigated rice production systems must be significantly increased. The existing strong interdependence between water use in the crop production subsystem and the operation of the irrigation facilities for water service elicits the need for pursuing a comprehensive agenda for improving the performance of rice irrigation systems.

Diversification

Since no major net addition to currently irrigated rice areas is expected in the coming decades and major breakthroughs in raising yields of rainfed rice systems are unlikely to be available during this period, most of this additional rice will have to be produced in irrigated areas. In rice irrigation systems, rice monoculture is overwhelmingly the dominant practice. Diversification of the crop production system in these areas is desirable for several reasons. First, diversification will open opportunities for increasing farmers' income from their limited land resources. This is particularly important at the present time when profits from rice culture are very low and declining. Second, it is increasingly evident that, as productivity of the land under rice monoculture under wetland conditions is declining over time, a diversified agriculture will be more sustainable in the long run. Third, with increasing scarcity of water, irrigated agriculture will have to aim at maximizing return to water rather than return to land. Present rice culture systems require more water than most other food crops, both in terms of quantity of food and calorie produced. Therefore, a major scope exists for increasing returns from water by growing diversified crops, especially in areas of water shortage. To enable farmers to diversify their cropping pattern, they must be provided with facilities to exercize crop choice options, which is presently lacking in most rice irrigation systems.

Upgrading rice schemes

The task of upgrading or modernizing an irrigation system for rice cropping in the wet season and for diversified cropping in the dry season is complex. It requires that any permanent structural or physical upgrading to be done for rice must also conform to the requirements of the diversified crops to be grown in the dry season. It is therefore logical to assume that the upgrading of common denominator factors, i.e. factors that are relevant for both seasons, could be upgraded permanently and these should be handled by the main irrigation system. Examples of these would include upgrading of water control, drainage, reliable schedule of water delivery, etc. at the main system. The on-farm, crop-specific factors could be handled seasonally by the farmers themselves as individuals or as groups. Examples of this type of upgrade would include the same items, as above, but at the farm level. Provision of flexibility will become an additional requirement.

Reliable water supply is critically important for diversified cropping, as farmers have to invest much more for these crops compared to rice. Areas that are far from the irrigation source generally suffer more water shortage in the dry season compared to near-by areas. Means of augmenting water supply in these areas, if they are suitable for diversified cropping, have to be found. Shallow groundwater development through the private sector is often the most reliable and affordable water source for this purpose. Groundwater has the advantage of being available on demand at the farm and able to avoid major water distribution problems.

Suitable methods of water application to the crop (e.g. basin, furrow or basin-cum-furrow), methods of controlling seepage from canals or neighboring rice areas (e.g. dykes, interceptor channel, dyke-cum-interceptor channel), or means of drainage enhancement (e.g. collector gravity drain, pumping, collector-cum-pumping) will be required. Diversified cropping requirements must be thoroughly considered in pursuing the modernization process, with the objective of raising farmers' incomes through provision of flexibility and option to choose crops in the dry season.

Water management for rice

As far as rice water management itself is concerned, whether one aims at raising water productivity or water use efficiency, it is now widely accepted that a river basin perspective should be adopted with much more attention being paid to defining the boundaries of intervention (farm, system, basin). Substantial progress has been made in defining concepts and methodologies (water accounting,

modeling, etc.) but available data, which are already woefully inadequate to assess the merit of interventions at the farm or system level, water abstraction and even cultivated and irrigated areas, are even more lacking for the adoption of integrated river basin approaches. More attention must also be paid to water quality issues and particularly the release of pollutants (fertilizers and other agro-chemicals) and salt concentration.

Nevertheless, practices which minimize irrigation inflow are of a direct interest to farmers who see their water supply rationed and have to pay an increasing share of its cost, for managers and developers who also face rationing because of degradation of water resources, dam siltation, transfer to other sectors, etc. and have an interest in minimizing pumping costs, and operation and maintenance as well as development costs, and indeed for water resources managers who need to plan future irrigation developments with minimum environmental impact from withdrawals or reservoirs. In addition, many major rice-growing areas are located in coastal plains. Furthermore, water saving practices, which require greater water control, typically are associated with or part of packages to improve agronomic practices and the efficiency of use of other inputs, and therefore play an important role in total factor productivity. They therefore contribute to increasing not only water use or irrigation efficiency but also to improving or sustaining water productivity. Indeed, water management methods, which improve water use efficiency, have been developed with a view to maintain crop yields and actually, when implemented properly, lead to yield increases (in the range of 15-20% in China for intermittent flooding and other methods). It follows that, although it is correct and necessary to use rigorous concepts for efficiency and performance at system and basin levels, and to determine under various conditions the optimum combination of improved technologies and water management practices that can meet water demand with least water consumed and managing return flows to ensure system and basin level efficiency, in practice it is difficult to find water management techniques proposed for adoption at the farm level which do not simultaneously raise irrigation efficiency and water productivity.

The range of possible strategies and their effect on various components of irrigation inflow requirements can be summarized in Table 1. The acceptance by farmers of the strategies and practices in Table 1 will of course depend on economic factors. Furthermore, they depend on improved water control and management of water at the system level, as well as adequate irrigation (in particular a reticulated irrigation distribution system) and drainage facilities. Their availability in China has allowed farmers to adopt the water savings techniques described above. However, typically, at that level, conveyance, field canal and distribution efficiencies are particularly sensitive to the quality of management, communication and technical control. When water supply within the system is unreliable, farmers try to store more water than is needed. In many large irrigation systems, few control structures at any level and poor drainage structures and poor drainage networks contribute to a waste of water.

TABLE 1
Rice, water management and irrigation strategies

PRACTICES	T	E	S&P	SRO	RCL
Developing improved varieties	x				
Improving agronomic management	x				
Changing schedules to reduce evaporation		x			
Reducing water for land preparation		x	x	x	
Changing rice planting practices		x	x	x	
Reducing crop growth water		x	x	x	
Making more effective use of rainfall			x	x	
Water distribution strategies		x	x	x	
Water recycling and conjunctive use					x

Being confronted with this rather large number of problems, it is not surprising that farmers are reluctant to shift to more demanding water management techniques than flooding. However, considering the growing water scarcity and pressure on the irrigated subsector within the water sector and on agriculture by other sectors of society and overall economic development policies described in previous sections, there is not much choice and farmers must be provided both with a conducive environment and a proper production tool, i.e. better performing irrigation services.

Improvements in the operation and maintenance of rice irrigation schemes through rehabilitation of the deteriorated systems, improvement of irrigation infrastructure for surface irrigation, irrigation management transfer, modernization, combining to various degrees institutional, organizational and technical changes, have been attempted in the region with mitigated degrees of success. Studies undertaken by the World Bank in recent years have evaluated the impact of irrigation projects. A study of 1995 evaluated the design of rice project in the humid tropics and concluded, from the strong degree of resistance of farmers to new design standards and the level of anarchy and chaos observed on the schemes, that the more reticulated systems, capable of supporting on-demand water delivery, were not appropriate under these climates. A more recent study (1997) assessed the agro-economic impacts of investments in gravity-fed irrigation schemes in the paddy lands of Southeast Asia, to determine whether and how the quality of O&M services influences the sustainability of those impacts.

At four of the six sites, the areas supplied by the irrigation systems were significantly less than planned. Cropping intensities were also substantially lower than expected at three sites and falling at a fourth. Only one scheme had attained both its area and intensity targets. Paddy yields varied widely —between schemes and in comparison with expectations— but a weighted average for the wet and dry seasons at all the schemes was about 3.3 tonnes, or 85 percent of appraisal projections. However, farmers had not diversified out of paddy. Indeed, the concentration on paddy had increased. Output was between 32 and 73 percent of appraisal estimates for five schemes. The returns had also been driven down by the decline of the international price of rice.

Overall, agency and irrigator performance appeared to be substantially better than expected. Farmers cooperated to achieve at least basic O&M objectives regardless of the level of maturity of the formal organization. There were no substantial negative constraints on irrigated production attributable to poor performance in O&M. Those O&M operations that are essential to keep sufficient

supplies of water flowing to the great majority of the fields were adequately carried out. The study also noted the dismantling of complex technological control systems installed in the 1980s in favour of fixed structures that have no adjustments and structures that adjust automatically to changes in water levels; the rejection by farmers of both rotations and gates. Rotations do occur, but they tend to break down under conditions of shortage, which is when they are most needed.

The main finding was that given that they offered poor economics and low incomes, these paddy irrigation schemes faced an uncertain future. Small-holder irrigated paddy could no longer provide the basis for a growing, or even stable, household economy, driving younger family members off the farms while older members who stayed behind concentrated on basic subsistence crops, social capital would erode and O&M standards were likely to suffer. As economies expanded, irrigated paddy would not be able to compete with the incomes to be had from other employment opportunities. Improved O&M performance would not rescue them.

The study recommended that:

- Sharpen the response to O&M failures by disaggregating O&M; identifying the poorly performing components; and dealing with disincentives specific to each, such as the tertiary gates that farmers below consider unfriendly.
- Simplify the infrastructure and operations technology by converting to fixed and automatic controls that need less human intervention and by supporting authorities that plan with the farmers to abandon equitable rotations by rationing water during emergencies.
- Promote the transfer of management to farmers and their WUGs judiciously by recognizing that organizing user groups pays off, but also accepting that immature WUGs cannot handle some management responsibilities.
- Improve household earnings by diversifying cropping systems and supporting research, extension, and marketing services keyed to specialty crops and integrated, high-value farming.

The findings and conclusions of these two studies, combined with the results of the evaluation of modernization projects conducted by IPTRID in 1998, seem to be rather pessimistic and contradictory. However, put together, they tend to indicate that present project designs or operations are not capable of supporting both economically and technically the intensified, diversified and more water efficient and productive rice production systems which will be required in the future. They also seem to indicate that purely software solutions or mere improvement of operation and maintenance do not deliver the expected results in terms of improvements in performance and yields. They also reveal that many modernization or improvement efforts have been inappropriate, poorly adapted to local circumstances and the specific character of rice-based production systems, and incomplete or fragmentary. Conjunctive is practiced within “modern” irrigation schemes: it may provide a solution but is not available in all places.

TOWARD SERVICE ORIENTATION

Design processes

Performance of irrigation projects is determined by a combination of physical, institutional and policy factors. The gap between potential and actual outcome is strongly related to over-optimistic assumptions of the hydraulic performance at planning stage, and in a number of cases to faulty and unrealistic designs as well as construction. The performance of operation of irrigation systems is influenced by the capacity of the management agency to apply the operational rules defined by the designer. Many designs are difficult to manage under real field conditions. The professional context explains why design irrigation engineers know little about actual distribution processes. Some of the

reasons lie in administrative and behavioural reasons, mostly associated with the lack of experience, effective accountability and feed-back from operation of design engineers, whether in irrigation agencies or in local and foreign consulting firms, in lending policies of financial institutions, in lack of accountability of operators and managers to the users. In countries with large development of irrigation, the state officials have often entrenched engineering practices. The planning, design and construction process must produce a system and conditions capable of accommodating effective management practices. IMT provides an opportunity to correct the administrative and behavioural reasons at the stages of design, construction and operation.

Modern design is the result of a process that selects the configuration and the physical components in light of a well- defined and realistic operational plan, which is based on the service concept. It is not defined by specific hardware components and control logic, but use of advanced concepts of hydraulic engineering, agronomy and social science should be made to arrive at the most simple and workable solution. The most important issue is the system ability to achieve a specific level of operational performance at all levels within the system. A proper operational plan is the instrument that combines the various perspectives and helps reconcile conflicting expectations between the users, the project manager, the field operators and the country policy objectives. The second step is the planning of an irrigation project is the decision about water deliveries i.e. the frequency, rate and duration of water deliveries at all levels of an irrigation system.

A water delivery schedule does not necessarily imply a specific design. A rigid schedule of water deliveries to the farm turnouts may use modern irrigation hardware and computerized decision support systems to make the water deliveries reliable and equitable, but a project designed for rigid rotation through simple non-adjustable structures or for proportional distribution cannot be operated for flexible water distribution. To a large extent, the layout, original design criteria and standards used for an irrigation project limit the options for its rehabilitation and modernization. In extensive irrigation projects with the objective of thinly spreading water, the design capacity decreases from upstream to downstream. Traditional delivery systems have no or little flexibility built into them and do not attempt to match water deliveries to crop needs. In responsive irrigation projects, the design capacity increases when moving downstream to accommodate the need for flexibility.

Key elements of sustainable service oriented I&D management

Sustainable service oriented irrigation and drainage management can be characterized by the following:
It is output-oriented: the cost of the service provision is based on well developed operation and asset management programmes; It involves users to determine levels of service and the associated cost of service

The irrigation and drainage organization should be able to recover the cost of service provision either from direct consumers or from subsidies; and it relies on an appropriate legal framework that provides protection for users, the organization providing service and the general interest of society

The decision on level of service

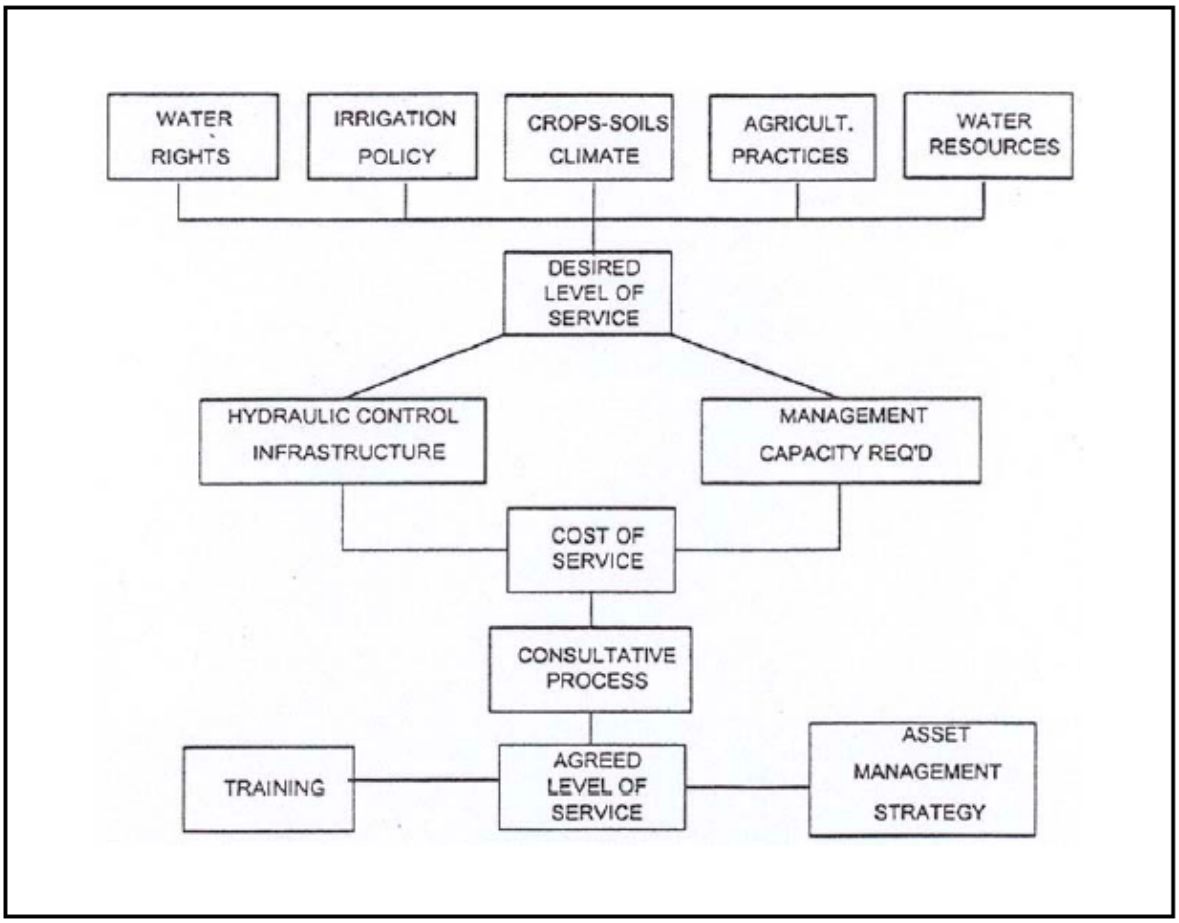
The level of service consists in a set of operational standards set by the irrigation and drainage organization in consultation with irrigators and the government and other affected parties to manage an irrigation and drainage system. It must emerge from an extensive consultation process. It should become a series of norms (targets) against which operational performance is measured. It must be revised on an on-going basis to respond to changes in irrigated agriculture and requires careful consideration of the cost associated with specific levels of service. A strategic planning and

management approach is recommended. The formulation of level of service specifications is the central decision for strategic planning and future operation and management.

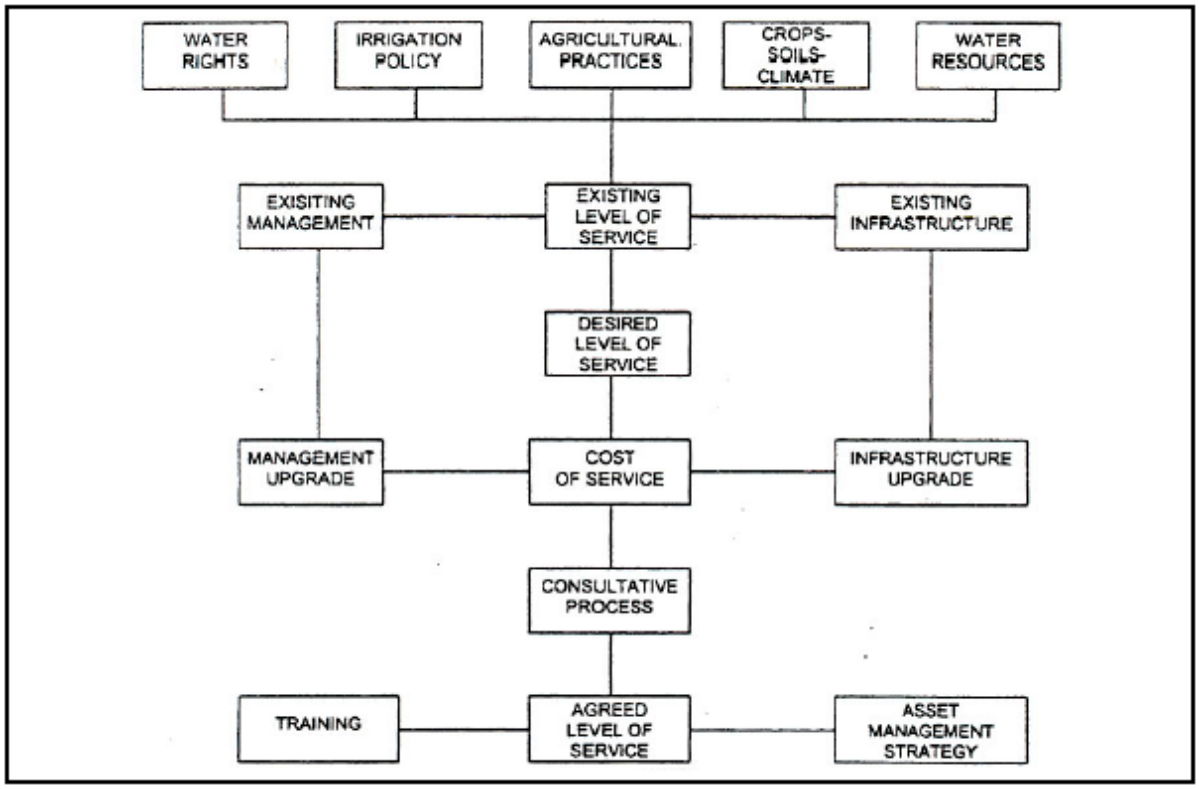
Service agreement

It is necessary for all service relationships to define services (transactions) and the conditions attached to them, and payment required for obtaining these services. These must be stated in quantifiable and measurable terms that are easily monitored and controlled. These can be formulated in service agreements in the form of contracts that contain details on the level of service to be provided by the organization, the obligations of customers and the organization and the process for resolution of conflict should these arise.

For a new or rehabilitated irrigation and drainage scheme the following process could be applied:



For existing drainage and irrigation schemes:



A service agreement consists of two main elements: transactions and accountability.

The service agreement should therefore contain details including:

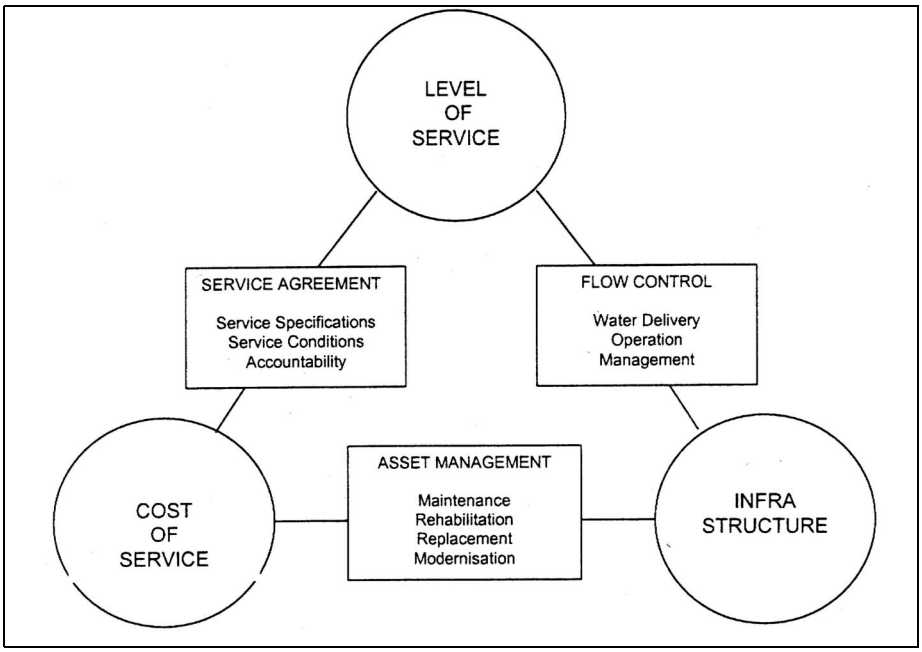
- Specification of service to be provided;
- Amount and form of payment of service by users;
- Monitoring procedures to verify whether services are provided as agreed;
- Liability to both parties for not fulfilling the agreement;
- Relevant authority to settle conflicts; and
- Procedure for reviewing and updating the service agreement

Accountability mechanisms defined through the service agreement provide: operational accountability: monitoring, evaluating, controlling and enforcing; strategic accountability: mechanisms that users have to control the formulation of the service agreement; and constitutional accountability: mechanisms by which users can influence the strategic decision making process of the organization.

Level of service, cost of service and infrastructure

The following figure illustrates the main relationships between the level of service, its cost and the infrastructure necessary to supply it. In particular, the same infrastructure can provide very different levels of service according to how it is operated.

FIGURE 3
Levels of service



Management of irrigation systems

Each level of service, to be achieved, depends on operational parameters. Requirements in terms of flow control systems and human resources must be clearly understood and planned for. It is also necessary to understand the internal mechanisms of irrigation systems, and to provide selective enhancement of those internal mechanisms, if irrigation project performance is to be improved. These 'details' are so important that it has been argued that investments must be based on specific actions to improve them, rather than deciding on the framework for detail improvement only after the investment is approved.

Management of irrigation systems in a business and service oriented mode is also a complex operation. It requires advanced managerial skills and the ability to process and interpret large amounts of data. A feature of modern design and operation is often the minimization of the collection of large amounts of data for statistical analysis while information needed for operation increases. For example water requests and water deliveries have to be recorded and matched with conveyance capacity, seasonal water allocation and total water availability. Water deliveries have to be converted into financial transactions. Payrolls and financial assets have to be managed as well as stocks, spare parts, vehicles and construction equipment. Maintenance programmes have to be implemented and closely followed.

Modern information and management systems are imperative to assist managers in performing efficiently their tasks. These tools can be used irrespective of changes in management structure, but the needs will also be felt by WUAs. The availability of management support tools can be seen as a means to facilitate their taking over their new managerial responsibilities.

Monitoring and evaluation

The effects of any programme that modifies the organizational arrangements for providing the service must be evaluated in terms of the quality of that service. In a typical IMT monitoring and evaluation

system, key issues about outcomes and impact include as potential immediate outcomes the quality of the water delivery service. Possible eventual impacts are related to socio-economics and productivity. Potential areas of interest for water users are estimated to be the quality of O&M, the cost of O&M, the use of funds collected, agricultural and economic productivity. Impacts, which are the indirect or ultimate effects of an intervention, include cropping intensity, number of crops grown, if design and operational rules are performance-oriented. M&E is meant to provide information but also to strengthen local management capacity, enhance skills and support problem solving by WUAs. Standard tools are: walk-through and inspection of irrigation systems, planning maintenance or rehabilitation priorities, preparing O&M plan, supervising field staff, conducting technical audits.

In the service concept, the outcome and impact indicators listed above are actually the specific objectives of service-oriented management. Indicators can be classified as indicators for comparing the performance of irrigated agricultural systems, or external performance indicators, and internal process indicators. External indicators examine values such as economic output, efficiency, and relative water supply (i.e. ratios of outputs and/or inputs). Targets are set relative to objectives of system management, and performance measures tell how well the system is performing relative to these targets. These performance indicators are primarily applicable to compare actual results with what was planned – say, to compare outputs from a project before and after. The objective of internal indicators is to assist managers to improve water delivery service to users. Internal indicators include indicators to concretely measure service at all levels and could be very useful in M&E systems as service is generally assessed simply by sampling or polling.

Irrigation management audits, asset assessment and management, benchmarking

Benchmarking, which uses primarily external performance indicators, could be introduced as a way for continuously assessing management performance before, during and after IMT and maintaining a dynamic of improvement. Irrigation management audits can be used to assess performance according to key indicators listed in a service agreement.

Where infrastructure is still owned by the government after IMT, they can be a joint exercise between the irrigation agency, WUA and local government to assess governance and service provision, including technical, financial and organizational aspects. A prerequisite for management audits is a detailed initial assessment of assets to be transferred with their condition and functionality, and systematic monitoring of assets through detailed survey and monitoring.

Design and operation for IMT

Management of a relatively large system is generally divided between various units. The locations of the interfaces between these levels have an important influence on the way the system is operated and its hydraulic performance. If management of the main system must be divided between units, the interface should be located at hydraulic 'breakdowns' such as reservoirs. The trend is to transfer the management of large sections of irrigation systems to large user associations, such as in Turkey and Mexico. The contractual approach to bulk supply provision or irrigation service provision may require changes in hardware and operational rules at the interface between the management levels. Precise, but user-friendly, control of flows and measurements of volumes is needed. Reforms often include the establishment of water rights and trade of these rights, and the pricing of water on a volumetric basis. The design of irrigation projects should take these reforms into consideration. A rigid system with fixed distribution structures is not compatible with water trading. Measurement and control are required where trading is expected to occur. The layout of the canal network should also be designed so as to be integrated with not only the roads and drainage system, but also with the multi-level of management, whether from the agency or user associations.

Economic evaluation

Conventional economics use a high discount rate for future costs and benefits and fail to show the importance of maintenance in sustaining the life of a system and the livelihood of farmers. The result is a that a project with a low initial cost, which deteriorates quickly and is dependent for continued survival on timely and properly funded maintenance, or with high operation costs (pumping schemes) is preferred to one that is constructed to need less maintenance or lower operation costs because it appears cheaper. Such a project may not sustainable without government subsidies, and will have to be abandoned unless governments keep a policy of subsidizing irrigated agriculture. Subsidies do leak to non-poor But lack of subsidies (or too low) may mean farmers – especially poor farmers – become unable to pay the full cost of water fees (especially if for example, prices fall as they have done for staples) and so unable to support private sector involvement. On the other hand, too much subsidization may mean investments are made in poor-quality projects, with low rates of return.

THE NEED FOR SUPPORT SERVICES AND CAPACITY BUILDING

Political commitment and a legislative framework are important to provide the basis for institutional reforms, but efforts devoted to institutional development and capacity building can determine to a considerable degree the success or failure of the devolution process. Defining which support services are essential to be provided is an essential step in the IMT process. Such services may include capacity building in managerial, financial and regulatory needs of water users associations as well as technical support for irrigation system operations, maintenance, rehabilitation and upgrading. Training of service providers should be an important part of the IMT process. However, support services is a critical component that is sometimes overlooked in the design of IMT programmes which have limited funding for capacity building. This section examines the type of support services needed for water users associations and farmers within irrigation systems and irrigated agriculture.

Support services after IMT

Capacity building is a long-term process and should not stop with the formal transfer of management responsibilities. Unfortunately, funding and support programmes are often limited to the IMT process and WUAs are left at a critical stage without much further support, endangering the sustainability of the WUAs. The different support services which may be needed after IMT are indicated below.

Support services offered by the WUA

Sustainability of water users organization will depend to a large extent on their capacity to provide an adequate water delivery service, to control and allocate water, to maintain the hydraulic infrastructure and to promote gains in agricultural services.

Support services that were previously provided by government agencies may also become part of the WUA responsibilities. These may include agricultural extension, technical assistance, legal matters and training programmes. Federations of WUAs can be fairly successful in providing a wide range of services in addition to the O&M and administrative services they have taken over.

Role of the irrigation agency in supporting irrigation management and modernization

The irrigation agency has been the main player in many IMT programmes during and after the IMT process. It is the main provider of support services, which typically include technical advise on O&M activities, and training and support in administrative and financial matters. It is important that irrigation agencies support the IMT process and have a clear understanding of their tasks and roles towards WUAs. In Andra Pradesh, continuing support to WUAs by the irrigation agency is ongoing and a programme of maintenance and rehabilitation is underway, in which the irrigation agency will

provide further training in O&M, budgeting and bookkeeping. A system of joint technical, financial and social audits of WUAs is being developed. Governments should specify clear policies whereby support services for rehabilitation and upgrading of irrigation systems will be provided after IMT. These should be designed so as to promote local self reliance rather than inefficient and unsustainable dependence on the government.

Strengthening agro-economic development

There appears to be a strong correlation between the productivity of irrigated agriculture and the sustainability of water user organizations. Hence, there is rationale for governments to promote development of agricultural production potential, intensification of farming systems, and development of agribusiness and marketing opportunities. Support services in IMT should therefore not be limited to water delivery and O&M tasks only, but should comprise support in all aspects that will improve performance and sustainability of irrigated agriculture. More support services are required in schemes with low agricultural productivity, to motivate and enable farmers to take over water supply services both technically and financially.

Role of agricultural extension

Agricultural extension played an important role during the years of the green revolution in promoting improved agricultural practices and contributing to substantial leaps in agricultural productivity. Trained to work closely together with farmers, agricultural extension workers could also play an important role in providing direct support to WUAs in intensifying irrigated crop production and promoting agribusiness.

With governments committed to the privatization of services, many extension agencies, however, are suffering from a lack of funding and decreased capabilities. Moreover, inter-agency competition is constraining or preventing an effective synergy of activities between agricultural and irrigation agencies and is reducing the inputs and support of the agricultural agency in many IMT programmes. Two questions arise: Is there indeed a need to redesign and revitalise government extension systems, particularly in countries with weak agribusiness sectors? Or is there need and potential for private sector or non-governmental organisations to take over agricultural extension services?

Role of the private sector in provision of agricultural supplies and credit

The private sector can play an increasingly important role in supporting irrigation management organizations. Suppliers of agricultural inputs, farm machinery and on-farm irrigation equipment may offer technical advice and assistance in further improvements of the irrigation and agricultural production system. Several countries report on the difficulties experienced by WUAs in owning and maintaining equipment for transport, desiltation, land leveling and construction works. It is apparent that many operation and maintenance tasks could be entrusted to specialized private sector contractors. Further, marketing and agribusiness organizations and suppliers of agricultural inputs may play an important role in the promotion of more profitable agriculture and supply of equipment and credit and provision of technical advise. However, this will likely involve contract farming and other business linkages with suppliers of agricultural support services. Agricultural credit plays an important role in intensifying irrigated agriculture.

Irrigation advisory services and on-farm water management

More effective use of water at farm level can contribute importantly to increasing and intensifying agricultural production. Studies have shown that an effective on-farm water management programme that improves the field irrigation and drainage system, promotes land leveling and introduces sprinkler or micro irrigation systems can increase harvested irrigated area and yields significantly. In most countries irrigation agencies have little experience and interest in on-farm water management, while in most cases agricultural extension workers have no expertise in water management. Specialised advisory services or on-farm water management programmes to introduce appropriate field irrigation technology and methods may need to be considered.

Role of river basin management organizations

Growing competition for water between different sectors has led to the formation of basin-wide organizations to regulate water management and to the basin-wide allocation of water to different interest groups within river basins and watershed catchment units. Agreement on procedures for water allocation and watershed management among different water users are important in this and require a forum for negotiation and consultation, entrusted to river basin organizations. Although institutional arrangements are, in many countries, still in formative stages, the role of river basin management organization in providing support services to irrigation management organizations may become increasingly important and may include legal advice and development and adjudication of water rights within basins.

Legal support

Even though initial legislation for the formation of management organization may be provided for at the start of IMT, continued support may need to be given to water users organizations to assist them to improve and modernize the regulatory framework in the water sector. Normally, further support and guidance will be required for matters of water rights, water allocation rules and regulations, protection of assets, resolution of disputes and imposition of sanctions.

Training and capacity building

Training and extension is an important tool for developing the knowledge and skills of farmers and WUA officials to undertake management responsibilities and develop more profitable irrigated agriculture. Generally, training of WUAs included training in financial and administrative management as well in technical aspects of operation and maintenance. However, the quality of training varies greatly and it is often reported to be not adequate or ineffective. Countries with a more focussed effort and commitment to IMT developed extensive training programmes for both WUA and staff of the irrigation agencies. Training has been directed to developing skills in financial and administrative management and technical operation of the system, but has been used in particular also as a tool to sensitize and motivate farmers, local leaders and staff of the irrigation agencies. Fewer IMT programmes included training for the irrigation agencies. This is surprising given the fact that the irrigation agency is normally required to play a central role in the transfer process.

Training often proved to be ineffective and more effective training approaches need to be developed. Agency staff at almost all levels need to be involved with trainers–of-trainers programmes. Also, in several cases reported in the profiles, WUAs may provide training support services to their members, in particular in agricultural production methods and in development of markets and agribusiness.

Cost of institutional development and capacity building

In many IMT programmes, only small budgets are provided for institutional development, training and capacity building. As the IMT process is often driven by the government's lack of funds, many countries fail to allocate the minimal funding required to establish an effective support programme to ensure the formation of sustainable irrigation management organizations. This may constitute a serious threat to the sustainability of WUAs after IMT. The impacts of well-designed training and capacity building programmes have not been studied in a systematic way and may be one of the reasons for the limited funding allocated to institutional development.

Case for extensive retraining of engineers and managers in irrigation agencies, consulting firms and irrigation service providers

Intensified and on-going training programmes for both professionals in the reformed irrigation agencies, consulting firms which provide advisory services to water users associations and managers of water users associations and the technical staff employed to operate and maintain their irrigation schemes are understood as one of the conditions for sustained success of the transfer programmes.

It is therefore essential that these programmes introduce and provide knowledge on ways and means to design and operate irrigation systems cheaply for good performance and adequate service to farmers as they evolve toward more commercial forms of agriculture. An appraisal of initial conditions and performance of the systems to be transfer would allow both a better design and strategic planning of physical improvements together with a definition of the service to be provided both by the irrigation service provider to WUAs and by WUAs to their members, with indications on ways and means to achieve these service goals and improve them in the future.

It is suggested that the Rapid Appraisal Process developed and used in the evaluation of modernization programmes of IPTRID could be used for this purpose at programme appraisal stage and for individual irrigation systems. The use of internal process indicators would be useful in monitoring and evaluation systems.

A pilot training programme on modernization concepts and application of the Rapid Appraisal Procedure, which builds on the knowledge synthesis acquired in recent years on modern design principles and participatory irrigation management shows promising results. Its application to a system in Thailand by staff of the Royal Irrigation Department gave very promising results. Similar training courses will be held in Iran, Viet Nam, Indonesia and Nepal. A concept for a more ambitious retraining programme based on the same concepts and tools has been developed by FAO and could be supported in the context of efforts to improve the performance of programmes to transfer the management of irrigation systems to the users.

CONCLUSION

The notion of water delivery service and of generalized service-orientation of institutions in the irrigation sector, whether river basin agencies, reformed irrigation agencies, irrigation service providers, water users associations has become central in new concepts and definitions of participatory irrigation management and irrigation management transfer. The evaluation of impacts of on-going participatory irrigation management and irrigation management transfer programmes is one of the reasons of this evolution.

Literature on the evaluation of impacts of on-going participatory irrigation management and irrigation management transfer programmes in terms of water service delivery, agricultural productivity and agricultural performance indicates that improved service is a problem area.

The service orientation of irrigation water delivery doers not appear to be sufficiently taken into account in processes and tools for design and preparation of operation and maintenance plans infrastructure rehabilitation works, monitoring and evaluation systems. For the large systems, partial or gradual transfer may not provide explicit steps for a real decision on service and the gradual building upstream of governance structures by federation a constraint to address the central strategic questions of service at the beginning of the transfer process. For small or traditional schemes, the question of future needs of irrigated agriculture is often not asked. IMT has rarely affected the design processes. The sustainability of the water users associations is however now seen to depend on their capacity to provide an adequate water delivery service and control and to allocate water and to provide an improved service to enable gains in agricultural productivity.

In the context of Asia, diversification of rice crops is a major issue for increased income by farmers and improved agricultural and water productivity. This in turn is essential for the capacity of farmers to pay water and the water users associations to e financially viable. A more forward-looking strategy anticipating these future needs is therefore required.

As a result, it is now recommended that strategies of gradual improvement of irrigation systems be adopted to support the transfer of water management responsibilities and associated rights. Concepts of irrigation management transfer/participatory irrigation management transfer and modernization are therefore converging. However, there are still some substantial differences: modernization stresses that the infrastructure/physical improvements which must be supported must be designed with a view to improve equity and reliability of water delivery service and evolve towards increasing levels of flexibility. Operational and technical details become very significant. Environmental considerations need to be better taken into account in a perspective of integrated water resources management.

A more forward-looking strategy anticipating these future needs is required. Recent visioning processes in the water sector provide a good condition for strategically planning organizational and technical changes in participatory and irrigation management. This in turn is essential for the capacity of farmers to pay water and for the water users associations to be financially viable. An appraisal of initial conditions and performance of the systems to be transfer would allow both a better design and strategic planning of physical improvements together with a definition of the service to be provided both by the irrigation service provider to WUAs and by WUAs to their members, with indications on ways and means to achieve these service goals and improve them in the future.

Although the relationship between design and operation is not univocal, initial system designs may represent a severe constraint to the adoption of new and more flexible operational procedures. Many problems related to inequity and unreliability of water service can be attributed to design and operational procedures, which, if left unchanged, will produce the same results whatever the governance setup. Many of the transferred systems cannot effectively provide needed or a reasonable level of service, now and in the future, with a limited programme of repairs or with rehabilitation. This threatens the capacity of the water users associations to carry the costs of operation and maintenance of the systems unless service is improved significantly and unless they are in a position to improve agricultural performance.

Knowledge in the field on how to design and implement service-oriented water control and management is lacking but capacity building components for agency decision makers and field staff, ISP/project operators and managers, consulting firms, water users associations do not address

sufficiently the practicalities of design, operation etc. on top of governance aspects and advisory services. Even if conjunctive use and recirculation are practiced in many cases, PIM/IMT often only concerns surface water systems and their management. This may be a problem for the viability of the newly created institutions.

Delivering an improved service, securing a water right, charging a water fee may require improved water control and measurement of discharges at all levels of the irrigation system. One can therefore argue that there is a case for reassessing the design, configuration and operational procedures at the moment of transfer as a result of a review or resetting of both internal objectives in terms of service with the water users and external objectives with water resources management institutions.

Another serious issue is to ensure that rehabilitation, modernization do not increase farmer dependence on the government, In particular, it is now thought that irrigation system improvement works should be planned and implemented after transfer. Subsidies may still be required but they should be smart. The new ideas about decentralized irrigation improvement funds are an example of these 'smart' subsidy systems that encourage investment of the users in the maintenance and upgrading of their schemes.

The required transformation of irrigated agriculture will not take place simply as a result of transfer and demand for improved services. Technical advisory services, financing arrangements, and other agricultural support services will be required.

Therefore, concerning the financing of irrigation and drainage systems in the context of water sector and institutional reform, the following conclusions can be made:

- IMT and PIM reforms do present good opportunities to redress the present under-investment in operation and maintenance or upgrading of irrigation and drainage systems;

- The service-orientation of irrigation and drainage service providers represents a new model for financing of irrigation and drainage services;
- One condition for the success of these reforms is that farmers be provided with a good service: this may entail a significant departure from mere cosmetic or light rehabilitation or upgrading which is typically financed in the context of IMT/PIM programmes in the region;

- A second condition for the sustained success of participatory irrigation management is the availability of financial instruments allowing farmers to invest in upgrading their irrigation systems;

- A third condition is a substantial increase in the training and capacity building components of these programmes;

- A fourth condition seems to be that irrigation sector reforms should be part and parcel of a more general reform of water resources management, in which issues of water allocation, water rights, ownership of transferred assets and the future of the irrigation agencies are addressed;

- Another condition for the sustainability of the reforms is the development of a suitable service environment to assist farmers in increasing the productivity of agriculture.

ANNEX 1

DECLINE IN IRRIGATED INVESTMENT?

Public investment in irrigation has declined

Data on irrigated areas, globally and across regions, show that the rate of growth in irrigated area has declined, and has been accompanied by a decline in lending for irrigation by international donors. There has been a large decline in real lending since the late 1970s and early 1980s, when it peaked. By 1986-87 World Bank lending was only around 40percent of peak lending, and lending by other donors shows similar trends.

Many Asian countries show a decline in real irrigation expenditure in the late 1980s. Annual expenditure in China and Sri Lanka was cut by nearly 50 percent between late 1970s and 1980s. In the Philippines the level in the late 1980s was only one-third that in the early 1980s. Expenditures peaked later in Bangladesh, Indonesia and Thailand, but these countries also show a decline in investment in irrigation. In India, public sector investment in irrigation has been stagnant or declining since the mid-1980s.

Private sector investment

What of private sector irrigation? Much groundwater is privately owned e.g. India, Bangladesh, so monitoring both use and development of groundwater sources is difficult. But data from FAO's AQUASTAT programme suggest that investment in groundwater development has offset the decline in public investment (mostly surface schemes). Indeed, the most significant innovation over the recent decades is estimated by many be the diffusion of low-cost low-lift pumps and tubewell technology.

Successful strategies for the dissemination of improved on-farm irrigation such as treadle pumps, low-cost drop and sprinkler systems and more generally small-holder land and water management systems are now understood to rely on private sector initiative (manufacturing, dealer networks, installation) and mass-marketing. The idea is that these investments are highly profitable. The issue is therefore to make systems that are accessible also to the poor or to facilitate their access to rural credit, and not to rely on subsidies that are typically shown to ration or limit the dissemination process.

In the Asia region, private investment in surface irrigation systems is still in its infancy or contemplated in the reform policy documents, mostly under the pressure from external donors. However, it is not totally absent and there are interesting examples to be found in China, Viet Nam or Cambodia. In Australia or New Zealand, IMT is often understood as privatization, as previously public assets are transferred. Although recent problems with privatization of other industries as well as domestic water supply has led to more caution in the promotion of privatization of irrigation services, this path to IMT should not be neglected.

In Latin America, private sector investment has historically been important and only gave ground to public sector investment during the 1970s. In Mexico, a substantial number of irrigation units covering a large proportion (around 40percent) of irrigated area were privately owned, even before reforms of publicly-funded irrigation districts shifted control to water user associations. Increases in private sector investment in irrigation infrastructure have been dramatic, and have helped compensate for the 41 percent decline in federal government investment between 1991 and 1995. In Chile, with one of the most privatised irrigation sector in Latin America, farmers have to, by law, contribute as much as 75percent to new pumping and channel irrigation projects, with the result that only the most profitable schemes are built. But the extent of private sector involvement in the

approval, funding and operation, management and maintenance of irrigation projects has increased water efficiency with booms in agricultural exports despite a small decline in irrigated area per capita.

In Mexico, the increase in private sector investment has led to improvements in performance of some irrigation systems. Removal of sediment from canals and drains, irrigation budgets and user contributions have all increased dramatically after irrigation management transfer from the public to the private sector. Increased water efficiency in Chile is largely attributed to the increase in private sector involvement. However private sector investment, especially by the poor, relies upon access to credit facilities and technical assistance, yet subsidies for infrastructure investments can create incentives to invest in non-viable projects or in projects with relatively low rates of return.

What are the reasons for the decline in public investment?

The decline in investment in irrigation is largely ascribed to falling economic rates of return to irrigation projects, both new and existing, making other sorts of investment better options for scarce resources. This may be because higher-return works are usually built first (the best sites for dams have already been chosen) leaving less good ones for later, because of rising costs of construction, or falling recovery of costs from users, declining agricultural prices, declining water-use efficiency or increasing negative impacts (e.g. health and environment).

Returns to irrigation are however comparable to alternative investments in agriculture and non-agricultural projects. In an evaluation of 192 World Bank funded irrigation projects implemented between 1950 and 1993, 67 percent received an overall satisfactory rating with an average internal rate of return of 15 percent at evaluation. There was no downtrend in ERR The relatively constant ERR is despite falling world agricultural prices and should carry through to, and parallel results for, trends in returns to irrigation.

There is also an argument that investment in irrigation is falling because of rising costs of construction. This may well be the case in some areas. In India and Indonesia the real costs of new irrigation have more than doubled since the late 1960s and early 1970s; in the Philippines real costs increased by more than 50 percent; in Thailand by 40 percent, and in Sri Lanka, costs tripled. The result is lower returns to investment.

Poor and/or declining cost recovery could be another factor that explains declining trends. Public irrigation projects “have been an enormous drain on government budgets” mainly because cost recovery falls short of covering the actual costs. For example, in Pakistan in 1984 approx. Rs 1 billion were collected in payment for public irrigation services. Operation and Maintenance costs were about Rs 2 billion and annualised charges for past irrigation investments were approx. Rs 5.9 billion. For five South and South-east Asian countries (Indonesia, Korea, Nepal, Philippines and Thailand), actual government receipts covered less than 10 percent of the full irrigation costs. Increased fiscal pressure to recover costs or to reduce subsidies may also make irrigation projects less attractive other things being equal, but presumably cost recovery problems will affect all public investments. Given the growing demand for domestic and industrial water, and other sources of water squeeze tightening, this argument becomes less defensible.

The biggest surge in investment in irrigation occurred in the 1970s, leading some to argue that this was due to the rise in agricultural prices, due in turn to the two oil crises raising prices of inputs and transport and unfavourable weather conditions, and to argue further that declines in agricultural prices make future investment in irrigation unwarranted. If these events were perceived to be significant and likely to extend into the long-run, then this argument may have some merit. It is possible however that falling agricultural prices now are a consequence of rising irrigated area and hence higher global yields, and even more if extra irrigation creates incentives to green revolutions in

seed-fertiliser use, and if these eventually raise yields (more accurately, net value added) more slowly than they depress farm prices (more accurately, farm output prices relative to farm input prices - fertiliser prices may be bid up, as well as crop prices down. However even if agricultural prices continue their downward trend, there is sufficient evidence that ERR can be maintained at acceptable levels.

A fourth reason behind declining investments in irrigation is declines in other aspects of irrigation performance in for example water use efficiency or conveyancing efficiency. Misincentives, such as poorly targeted subsidies, or inappropriate water pricing systems can induce overuse or wastage of water and eventual water table depletion. Inefficient irrigation damages the performance of projects.

ANNEX 2

IRRIGATION DEVELOPMENT AND POVERTY ALLEVIATION

On-going research by FAO suggests that irrigation development has played a large role in poverty alleviation in Asia. There are huge regional differences in the proportion of cropland that is irrigated and these coincide with successes or failures in poverty reduction. In Africa only around 3 percent of cropland is irrigated and the region has experienced very little reduction in poverty in the 1990s [SSA had a poverty headcount of 47.7 percent in 1990 and 46.3 percent in 1998]. In contrast, 35-40 percent of cropland in Asia is irrigated and poverty reduction in the 1970s was substantial. The research argues that this is no mere coincidence, rather that differences across regions, countries and states within countries in irrigation is an important factor in determining rates of poverty reduction. The significant poverty reduction in many parts of India for example is attributed to the availability of irrigation, which not only boosted agricultural production but also made possible the adoption of modern farming technology – seeds, fertilisers and pesticides – that further reduced poverty.

Irrigation and poverty alleviation

Irrigation may take many different forms from large dams and canals to small systems of shallow tubewells, small sprinkler systems and porous pots. Irrigation may impact differently on the poor, depending on the irrigation technology itself, their position along the distribution system, the institutional rules governing access to water and maintenance of water systems and their ability to complement irrigation with other agricultural inputs. Furthermore the poor are not a homogenous group of people defined uniformly by a set of characteristics. instead they are much more heterogeneous, comprising different ages, gender, ethnicity, education, different economic activity and location. Irrigation may affect different types of poor people in different ways: perhaps impacting on small farmers first through boosting yields and income levels, then impacting on landless labourers through increased demand for agricultural labourers, and then on the urban poor via lower food prices and possibly reduced migration of the rural poor to urban areas.

Irrigation facilities also require labour and other domestic inputs for its construction and maintenance. A project in Nepal that used labour-intensive construction to provide irrigation increased production potential by over 300 percent and income by over 600 percent, contributing immensely to food security. The impact of irrigation on poverty via employment will depend on the type of irrigation system used. For example, centre-pivot sprinkler systems - often hundreds of yards long - are a classic big-farm-biased, capital-intensive means to water control; but the same effect can be attained more labour-intensively through gravity-flow. The aim in both cases is to achieve better

crop per drop, to save water: in one case with capital, in the other with labour. Price is one means to influence this choice, research and extension, another; land reform, a third.

Impacts of irrigation on poverty via output, employment and prices

The first direct impact of irrigation on poverty is on output levels. Irrigation boosts total farm output and hence, with unchanged prices, higher farm incomes. Increased output levels may arise for any of at least three reasons. Firstly irrigation improves yields with a fixed amount of rainfall through reduced crop loss due to erratic, unreliable or insufficient water supply. Secondly, irrigation allows for the possibility of double-cropping, and so an increase in annual output. Thirdly, irrigation allows a greater area of land to be used for crops. Hence irrigation is likely to boost output and income levels.

The second direct effect on poverty is via employment. Irrigation projects require labour for construction and on-going maintenance of canals, wells and pumps etc. This is likely to be an important sector of employment for the poor, especially the landless rural poor or rural households with excess labour or seasonal excess labour. In addition, increased farm output as a result of irrigation will stimulate demand for farm labour both within the main cropping season and across new cropping seasons, increasing both numbers of workers required and length of employment period. Rural poverty levels may therefore be reduced by increased employment opportunities. In addition there may be effects that extend to other areas if irrigation projects reduce migration to urban areas, and so reduce the pool of job-seekers and reduce pressure on the downward pressure on urban wages and the upward pressure on prices of housing and other urban infrastructure.

The third direct effect on poverty is via food prices. If irrigation leads to increases in staples or non-staple food output then this may result in lower prices for staples and food, in imperfectly open economies or if there are significant transport costs internationally, or from food surplus areas to towns or food deficit areas. Net purchasers of food will therefore gain from cheaper food, as will urban consumers.

Hence, examining the direct first-round effects, irrigation is likely to reduce poverty, via increased food output, higher demand for employment and higher farm real incomes among a) net food purchasers in irrigated areas, b) net food purchasers in non-remote unirrigated areas and c) the urban poor. Positive effects may be experienced by net food producers and waged labourers if effects of, respectively increases in output and employment outweigh effects of price falls. [This is increasingly likely with liberalisation of food trade; with falls in growth rate of irrigated area; and with better transport and falling transport-cost/production-cost ratios]. Negative effects might be experienced by surplus producers in remote, unirrigated areas but net food buyers there – who are usually among the poorest – gain from price falls.

Longer-run impacts

In the longer run, irrigated land may encourage farmers to adopt or increase their use of fertilisers, pesticides, improved seeds and other agricultural inputs, and provide the stimulus for further research into improved plants and technology that lead to increased output, and so employment and incomes, with possible further price reductions. This green-revolution style virtuous circle is likely to lead to further poverty reduction.

Furthermore, irrigation probably switches farm use away from staples to higher-value products. As long as the rural poor can access appropriate new technologies, possibly also requiring access to credit markets, then poverty among small producers and landless labourers is likely to fall. The switch of crops in irrigated areas may also create or expand demand for the crops of unirrigated areas, so leading to poverty reduction in those areas. Examples of this can be seen in the context of modern seed varieties.

A second longer-run effect on poverty is via non-farm rural output and employment. As farm output and incomes rise and food prices fall, enriched farmers and workers will increase their expenditure on non-food products, leading to increased demand for non-food goods and services and so increased employment opportunities in non-farm incomes generating activities. These may include transportation, construction, food preparation and trading.

Perhaps the biggest long-run effect on rural poverty however is via stabilisation and risk reduction. Crop output levels will not only be on average higher but also experience less variance over seasons – because of double cropping for example– and over years as reliance on rainfall is reduced. Hence the poor are less likely to need to borrow to smooth subsistence consumption levels and so avoid the high capital market access costs that they usually face. In addition, less risky production of staples or other crops allows them to take more risks with other activities, encouraging diversification into higher risk but potentially higher income activities, such as cash crops for export or new non-farm activities.

To the extent that poor farmers do have access to irrigated land and other agricultural inputs, then the effects of irrigation via output, employment and prices, stabilisation and risk reduction are likely to be positive in both irrigated areas and unirrigated but non-remote areas. Remote unirrigated areas are likely to experience negative effects if transport or other market transaction costs are significant. The greater availability of food output, lower prices and reduced pressure on urban resources is likely to be positive.

Irrigation can help or harm the poor depending on how they are involved in the delivery, management and maintenance of irrigation systems. Water User Associations vary from system to system, in size and composition, and the extent of control they have over operations and maintenance of systems. If the poor actively participate and are fairly represented in WUAs then equitable or even pro-poor allocations of water at affordable cost may ensue. On the other hand, if the poor are marginalised, or not properly represented in WUAs then inequitable allocations may occur.

In summary

There are a mixture of short-run and long run economic, socio-economic, environmental and political effects of irrigation that may have adverse or positive effects, and may affect different types of poor people [landless labourers, small farmers and the urban poor] in different ways. It is likely that cheaper, more abundant and stable food supplies, more farm employment, stabilisation and risk reduction, and spill-over effects to non-farm activities will be poverty reducing for large categories of the poor, although some groups, such as small food surplus farmers in very remote rural poor, may be negatively affected. However, the negative externalities of irrigation – on health and the environment – may be locally very damaging. Irrigation affects poverty via a variety of different transmission effects and different types of irrigation system affect different types of poor people. The chief effects are via increased employment and lower food prices: most of the poor (even the rural poor) gain an increasing share of their income from employment and are net food purchasers. As well as raising mean levels of employment, output and incomes, irrigation can also help reduce the variance of each, although there may be increased covariance. However, distribution of ownership of and benefit from water and water-yielding assets - small/big farm bias, and labour or capital intensity in use of new irrigation – is critical.

COUNTRY PAPERS

Investment in land and water in Bangladesh

INTRODUCTION

The physical environment

Bangladesh lies between the 20°25' and 26°38' north latitudes and the 88° and 92°40' east longitudes astride the Tropic of Cancer and the 90° east meridian. Its total area is 144 852 km^2, of which about 9 700 km^2 is occupied by major rivers and estuaries. It has a tropical monsoon climate with four main seasons: pre-monsoon (March-May); monsoon (June-September); post-monsoon (October-November); and winter (December-February). The mean annual temperature is about 25°C, while mean monthly temperatures range from 18°C in winter to 30°C in the pre-monsoon season. Mean annual rainfall is 50" to 60" in the west and over 100" in the north, east and south, and exceeds 200" in the far north. Some 85 to 90 percent of total annual rainfall occurs between April and September, with regional variations.

The country is comprised of hills, terraces and floodplains. The northern and eastern hills occupy 12 percent of the country, so-called terrace areas (the Madhupur and Barind tracts) about 8 percent and floodplain is the remainder. Terraces are uplifted fault blocks and not river or marine terraces (Brammer, 1997). Floodplains are categorized in four types: active river floodplain; meander floodplain; piedmont; and estuary and tidal floodplains. Since 80 percent of Bangladesh is floodplain, flood control and drainage not only supports crop irrigation but also prevents damage to crops and land of special importance in terms of food security.

Agriculture operates in a dual water regime of flood during the rainy season and aridity in the winter. A complex network of watercourses drains an area of some 2 million km^2 of which only about 7 percent lies within national boundaries. This physical setting severely limits the degree of control and management that can be applied to water inflow both in the monsoon season and during the dry winter. This variation in the temporal and spatial occurrence of water is a major constraint to economic development, especially for agriculture, which dominates the economy. The overabundance of water during the annual monsoon season causes widespread flooding and restricts cropping alternatives. It disrupts normal life. Significant areas of crops are damaged in years of high flood. Conversely, the scarcity of freshwater inflow during winter and at times of heavy groundwater use for irrigation has led to the progressive salinization of coastal aquifers and the environmental degradation of important economic resources such as the Sunderbans (Proceedings, 1992). The combined total annual monsoon flow of all rivers together is estimated to be 5 million m^3/secs which dwindles to 0.25 million m^3/sec during winter. About 71 percent of the total cultivable area is in higher areas (flood depth 0-30 cm) and medium high land (flood depth 30-90 cm), yet even the remaining land area is not entirely free of seasonal inundation.

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Importance of land and water

Bangladesh is an overpopulated country with a population density of 891 persons/km^2. The need to produce enough food for all has been a continuing concern for all governments since 1972. Land and water in this context constitute the two most important resources. All too often these resources have been used as though they are inexhaustible gifts of nature. Only in recent years has it been realized that these critical resources are limited, more so on a per capita basis, because of the huge population dependent on them. The current population estimate is 131.5 million (Bangladesh Economic Survey, 2001).

There are four principal modes of water development: (i) flood control and drainage; (ii) major irrigation, involving primary pumps, floating pumps or barrages; (iii) minor irrigation, involving traditional non-mechanized methods or modern mechanized methods using hand tubewells (HTW), low-lift pumps (LLP), shallow tubewells (STW) or deep tubewells (DTW); and (iv) flood control and drainage combined with irrigation using double pumping or single pumping with gravity distribution. Important subsidiary modes of water development include water conservation, command area development, and conjunctive operation of surface and groundwater irrigation systems.

Our objective is to highlight the major issues relating to land use and water management. This study in divided into four parts. Part I documents land and water development programmes executed in different plan periods, budget support including external aid and related issues. Part II delineates the historical trends in economic policies which influence investment trends including the priority given to land and water development and projections for future investment requirements. Part III deals with the growth of private investment in land and water, impediments to such investment and the areas and levels where a complementarity between the two could be established. Finally, in Part IV conclusions are drawn with emphasis on the Special Programme for Food Security (SPFS) and poverty alleviation through land and water development.

PART I: LAND AND WATER DEVELOPMENT PROGRAMMES

In Bangladesh, land and water development programmes cannot be kept isolated unless programmes of land development are narrowly confined to soil resource development to maintain and augment soil fertility. However, investment in soils resource development generally goes beyond the objective of maintaining soil fertility. The process of development in this respect includes soil mapping and classification of soils by type, checking the level of soil fertility in order to advise the farmers of the suitability of particular types of land for different crops. Bangladesh has made investments in soil resource development since the 1960s; it has institutional arrangements to continuously advise farmers on soil fertility issues countrywide. The Soil Resource Development Institute (SRDI) is the permanent institution in which investment is made under both development and revenue budgets; it is technically backstopped by the National Agricultural Research System (NARS).

Overall emphasis and consequent investment favours water resource development, which directly and indirectly serves the needs in both categories. The direct contribution of water resource development arises out of such programmes as coastal embankments, flood control embankments and flood control and drainage, land reclamation and river erosion control. The coastal embankment programme prevents salinity intrusion, thereby saving agricultural land. Flood control and drainage programmes save not only crops, but also infrastructure, human population and livestock. Flood control, drainage and irrigation programmes enable farmers not only to be free of flooding, but also increases cropping intensity through irrigation facilities. Programmes for river erosion prevention are important in reducing land loss. It is estimated that the annual loss of agricultural land due to such erosion is some 8 700 ha. Water resource development programmes since the early 1960s were largely

piecemeal and not interconnected due to the absence of a coherent sectoral policy. The National Water Policy adopted in 1999 provides for a comprehensive framework encompassing all sectors. Investment in land and water therefore must be seen in this light. The integrated relationship of land and water development was acknowledged in 1989. The Bangladesh Water Development Board (BWDB), the major public sector agency responsible for water sector development, built 6 519 km of dykes including 3 674 km of sea dykes, 6 095 large and small sluices, 1 276 large regulators, 6 419 km of drainage and irrigation canals, two cross-dams reclaiming 124 000 ha of new land, one barrage to protect 2.84 million ha from upland and tidal flood hazards and brought 192 000 additional ha under irrigation (UNDP, 1989).

An estimated US$1 billion in foreign aid was applied to water projects from 1972 to 1989, including investment in minor irrigation, which until 1989 was the responsibility of a public sector agency called the Bangladesh Agricultural Development Corporation (BADC). A policy change transferred this responsibility to the private sector, with the exception of a few areas of integrated area development.

Budget support

Bangladesh began planned development in 1973 with development in the form of five-year plans on which annual development programmes (ADP) are prepared. There have been some discontinuities due to the exigencies of public situations. Thus, while the First Five-Year Plan was launched in 1973, a Two-Year Plan (1978-1980) followed it in response to worldwide inflation and uncertainty. In 1980, the five-year plan framework was reinstated and three five-year plans were implemented in succession. There was no development plan during 1995-1997, but the Fifth Five-Year Plan was launched in 1997. Bangladesh is now preparing its Sixth Five-Year Plan. Funds for investment in development projects are channelled through the development budget. Funds are also provided through the revenue budget for the permanent offices that execute the projects. All the above plans give varying priority to land and water development programmes to achieve national self-sufficiency in food. Allocations and expenditures for agriculture, water resources and rural development in different plan implementation periods is shown in Table 1.

Extent of foreign aid

The allocation shown in Table 1 includes external assistance from bilateral and multilateral sources. Foreign aid consists of project aid (loan or grant), commodity aid or food aid. Project aid dominates the foreign aid component. It sometimes includes technical assistance in support of project implementation as well.

From independence until June 1998, US$33.2 billion in foreign aid was disbursed to all sectors of the economy, 48.4 percent as grants and 51.6 percent as loans. Of this, 17 percent was food aid, 29 percent was commodity aid and 54 percent was project aid. Since then, significant changes have altered the total aid profile. In recent years, emphasis has been given to social sectors such as health and education, which has led to declining support for land and water sector programmes. The share of grants overall has declined as has bilateral aid, decreasing from 74 percent of total aid in 1971-1976 to 39 percent in 1997-1998. Food aid also declined consistently from 48 percent of total aid in 1971-1972 to 7.4 percent in 1997-1998. Commodity aid fell from 50.8 percent to 9.5 percent during the same period.

TABLE 1
Allocation and utilization in the public sector during different plan periods

Plan Periods	Agriculture, Water Resources And Rural Development				Total Country			
	Allocation		Utilization		Allocation		Utilization	
	Billion Taka	Billion US$	Billion Taka	Billion US$	Billion Taka	Billion US$	Billion Taka	Billion US$
First Five-Year Plan (1973-1978)	10.41	0.83	6.18 (59)	0.49	39.52	3.17	16.35 (41)	1.31
Two Year Plan (1978-1980)	8.98	0.59			32.61	2.12	24.02 (74)	1.56
Second Five-Year Plan (1980-1985)	55.5	2.50	41.49 (75)	1.87	111.00	5.00	103.28 (93)	4.65
Third Five-Year Plan (1985-1990)	70.60	2.25	45.88 (65)	1.46	250.00	7.97	171.29 (69)	5.46
Fourth Five-Year Plan (1990-1995)	78.05	2.02	63.48 (81)	1.64	347.00	8.98	274.08 (80)	7.09
Fifth Five-Year Plan (1997-2002)	185.50	3.76	46.63* (25)	0.95	858.94	17.41	217.95* (25)	4.42

Source: Plan Documents, Planning Commission, Ministry of Planning, Government of Bangladesh.
Note: For the Fifth Five-Year Plan actual utilization shown for the period 1997-1999. Figures in parentheses indicate percentage of the allocation. Average exchange rates of different plan periods have been considered for converting Taka into US dollars.

From 1996/1997 to 2000/2001 the flow of external aid for agriculture, including minor irrigation and the water resource sectors, remained static (see Table 2).

In this respect, it is important to refer to the global context regarding external assistance to agriculture, including water resources and land. Available data indicates that the decline in external assistance to agriculture in 1994 reflected a 30 percent real term contraction in bilateral commitments.

This was partly counterbalanced by a five percent real increase in multilateral commitments in 1994. Nevertheless, total multilateral commitment to agriculture in 1994 remained well below levels recorded in 1993.

TABLE 2
Project aid 1996/1997-2000/2001

Year	Total		Agriculture, Water Resource and Rural Development	
	Billion Taka	Billion US$	Billion Taka	Billion US$
1996/1997	49.24	1.15	14.23 (29)	0.33 (29)
1997/1998	51.14	1.12	13.97 (27)	0.31 (27)
1998/1999	57.74	1.20	17.55 (31)	0.37 (31)
1999/2000	67.50	1.34	19.26 (29)	0.38 (29)
2000/2001	74.74	1.40	16.42 (22)	0.31 (22)

Source: Revised ADP Documents, Planning Commission, Government of Bangladesh.
Notes: Allocations in US$ takes into account actual exchange rates in different years. Figures in parentheses indicate percentage of total allocation.

With regard to regional distribution of foreign assistance flow, the level of commitments to Asian countries fell more steeply than for other regions during 1990-1993 (FAO, State of Food and Agriculture, 1996). This was the trend prior to holding of the World Food Summit (WFS) in 1996. This trend has not been reversed. The share of concessional assistance to agriculture in total commitments was estimated at 65 percent in 1998, well below the 77 percent share in 1988 and 74 percent in 1996.

Targeted activities

Targeted activities in land and water can broadly be divided into (a) activities directly related to land, such as soil resource development, land reclamation and development and management of accreted land and (b) flood control, irrigation and drainage.

Soils

Even prior to its birth in 1971, Bangladesh had invested in soil resource development. Nearly all agricultural land was covered by a reconnaissance soil survey conducted in 1963-1964. According to the demands of agricultural research, extension and development agencies, further activities aided by the United Nations Development Programme (UNDP) and the Food and Agriculture Organization (FAO) were undertaken to update existing soil and land use data, taking into account changes in hydrology, irrigation and drainage since 1974. Efforts were also undertaken to establish a mechanism for the transfer of knowledge of soils and land use to farmers, development officials and students through varied project instruments. The Department of Soil Survey (DSS) became the SRDI.

The activities of this institute have since been extended to make it more pro-farmer to provide advice directly to farmers through mobile laboratory units. Further, it is engaged in continual updating of relevant information on soils in nearly 460 subdistricts. The data collected is published and distributed to the farmers. Regular training of farmers on soil health issues is conducted in the field with participation of research and extension personnel. Soil health cards have also been introduced as an experimental programme.

To improve zinc and sulphur deficiency in soils, the private sector has been drawn into the marketing programme for zinc and sulphur, with positive results. In addition, the Department of Agriculture Extension (DAE) in cooperation with NARS have ongoing activities to educate farmers in adopting cropping patterns conducive to soil fertility, better land management, and balanced use of bio-mass, green manure and chemical fertilizers.

The programme for land-related activities is further strengthened by a geographic information system (GIS) covering 30 agro-ecological zones (AEZ). A database of this biophysical information has been developed. The AEZ/GIS project also provides training for agricultural extension, research institutes, universities, NGOs and the private sector.

Water resources

Activities relating to water resources can be categorized into irrigation, flood control and drainage. Irrigation is further divided into minor and major irrigation. Other activities include land reclamation, development and management of accreted land and for river erosion control.

In practice, the three components (flood control, drainage and major irrigation) often merge to form distinct types of activities known as flood control and drainage (FCD) and flood control, drainage and irrigation (FCDI). The distinction between FCD and FCDI is based on the objectives and functions of particular programme activities. Some activities relate exclusively to flood control and drainage, while others combine flood control and drainage with irrigation, depending upon the objectives and the needs assessment of a particular programme. The overall objective – regardless of programme activities – is to ensure water resource management and development in an equitable, comprehensive and integrated manner. FCD and FCDI programmes are capital intensive and require public sector investment. Due to perceptions associated with large scale FCD and FCDI projects in the late 1950s and early 1960s when a feasibility study after severe flooding in 1954-1955 led to recommendations for large-scale flood protection schemes to save crops from flood damage. A master plan was initiated and in 1959 the Water and Power Development Authority (WAPDA) was created. Later, these perceptions changed. This will be discussed in Part II.

Management approach

The creation of WAPDA led to public sector-dominated management of the water sector with WAPDA as its focal point. In 1961 BADC took over minor irrigation activities. Its birth is associated with the Food and Agriculture Commission Report commissioned by the then Government of Pakistan.

Pakistan's net area of cultivated land is estimated at more than 9.0 million ha of which 7.56 million ha are suited to irrigation. Flood control and drainage facilities are provided to 4.45 million ha of land (Fifth Five-Year Plan Mid-term Review).

Since creation of WAPDA and BADC in the late 1950s and early 1960s, Bangladesh has followed a public sector management approach in water resource development, the broad objective of which aimed at achieving food self-sufficiency as well as to protect infrastructure and damage to human and animal lives. In many ways, however, over time these objectives also promoted optimal water use, securing people's participation and integrated area development. FCD and FCDI programmes and projects remained within the WAPDA domain. Minor irrigation remained within the sphere of the BADC, which was also responsible for ensuring efficient delivery of inputs such as high yielding varieties of seeds (HYV) and chemical fertilizers. Further, it organized farmers to promote and develop horticultural production.

TABLE 3
Public sector irrigation to 1978

Type of Irrigation	Irrigated Area (million ha)
Major Irrigation	0.06
Minor Irrigation LLP DTW STW	0.71 0.55 0.14 0.02
Total Public Sector Irrigation	0.77

SOURCE: Two Year Plan, 1978-1980, Planning Commission, Government of Bangladesh.
NOTE: LLP=low lift pumps; DTW=deep tubewells; STW=shallow tubewells

Achievement to 1997

By 1978, 1.16 million ha were being irrigated, with traditional methods dependent on surface water accounting for 0.39 million ha (representing private sector investment). The achievement by the public sector-led management approach is shown in Table 3.

Irrigation, specifically minor irrigation development has had a major shift from public sector to private sector investment since 1987. The removal of the import ban on diesel engines of specific makes and models led to a rapid increase in private sector investment on STWs and LLPs. From 1988/1989 further policy reforms to remove duties and standardization restrictions on imports of small diesel engines encouraged further expansion of private sales of STWs and LLPs. By 1996/1997 four million ha of cultivable land was brought under irrigation coverage by both the public and private sectors. Details on irrigation coverage by type are shown in Table 4.

Flood control and drainage facilities were provided to 1.82 million ha by 1978. Facilities were extended to 3.17 million ha by 1987/1888 and to 4.2 million ha by 1996/1997 (Fifth Five-Year Plan).

Impact on food security

It is understood that the concept of food security need not be fully dependent on food availability. However, the concept can nevertheless be viewed in terms of the fact that a rising level of food production and its availability is a necessary if not a sufficient condition for food security. Food grain production in Bangladesh rose from just over nine million tonnes in 1960 to over 16 million tonnes in

TABLE 4
Irrigation achievement from 1987/88 to 1996/97 (million ha)

Types	1987/88	1996/97
Irrigation	**2.35**	**4.00**
Surface Water	0.88	1.15
Gravity flow	0.11	0.40
LLP (including floating pumps)	0.53	0.58
Traditional method	0.24	0.17
Groundwater	1.47	2.81
STW	0.87	2.23
DTW	0.56	0.53
HTW	0.04	0.05
Others		0.04

Source: Fourth Five-Year Plan and Fifth Five-Year Plan, Planning Commission, Ministry of Planning, Government of Bangladesh..

1987/1988. Through 1996 it ranged from 17 to 19 million tonnes and then rose again through 2001 to over 26 million tonnes. It may not be appropriate to link this rise exclusively to investment in land and water management. It was also affected by technological changes not only in the land and water sectors but also by the introduction of HYVs and the increasing use of chemical fertilizers, in which the NARS, the DAE and BADC and the private sector made significant contributions.

Due to the rising production of cereals in the past, cereal prices remained affordable. This contributed to food security because about 70 percent of average protein intake is rice. Additionally, due to recent achievements in food self-sufficiency, government has been able to expand safety-net programmes especially for women and children. These include the Vulnerable Group Development (VGD), Rural Maintenance (RMP or cash for work) and Food for Work (FFW) programmes. The beneficiaries of VGD and RMP are all women. Under the VGD programme about 0.5 million female-headed households receive 31.25 kg of foodgrain every month for an 18-month period. New groups of women are brought into the programme after graduation of the existing groups. The beneficiaries are given skill development training to enable them to earn their livelihood after completion. A recent government study found that marginal propensity to consume is greater for transfers in kind than for

cash. Consequently food transfers greater positive impact on food consumption than cash transfer of an equal monetary value, ensuring better food and health security for the hard-core poor. The larger investment in agriculture, water resource and rural development sectors is therefore a necessity to expand the safety net as well as to ensure food availability at an affordable price (Mid-term Review, 1997-2002). There is strong evidence that food assisted programmes increase household food security and promote human development for the vulnerable poor.

Employment and income generation

The impact of investment in land and water can be assessed by the fact that out of about 132 million people, 80 percent live in rural areas. They are directly or indirectly engaged in a wide range of activities relating to land and water. Sixty-three percent of the total population lives on land and water resource management.

The spread of new technology in crop agriculture instrumented through HYV seed, fertilizer and irrigation has increased the aggregate volume of marketable surplus of food grains. This has led to the creation of employment in agro processing, trade, transport and service sectors. As the new varieties are grown the demand for labour increased by 45 percent and work became available during the lean season (Mid-term Review).

Irrigation expansion has also led to increased employment opportunities in crop agriculture, as well as in the installation, operation and maintenance of pumps, preparation and maintenance of irrigation channels, on-farm water distribution, equipment trade, workshop facilities for equipment repair and spare parts manufacturing. Trading in seeds and fertilizers has also created significant additional employment opportunities in the private sector.

Investment in land and water centring on HYV seed-fertilizer-irrigation technology has made significant impact on poverty alleviation. The diffusion of agricultural technologies has also changed the nature and terms of tenancy in the land market with some favourable impact on income distribution and poverty alleviation (Mid-term Review).

Benefits from land and water

Apart from increased food grain production there are environmental and social benefits deriving from investment in land and water, in particular, flood control and drainage projects. These benefits cannot be easily quantified. Construction of 6 519 km of dykes including 3 674 km of sea dykes completed by 1989 (later rising to 7 900 km) saved the lives of coastal farmers and the crops they grew from salinity intrusion and tidal hazards covering some three million ha.

As noted above, investment in food distribution programmes leading to investment in land and water provided positive results in expanding the food security net. Programmes such as RMP and FFW have not only provided food, but also enabled government to invest in land and water in rural areas. Under RMP destitute women are organized for maintenance of rural roads; the programme currently employs 41 000 destitute women who are also provided training in other income generating activities. The annual maintenance of rural roads provides farmer access to markets. FFW added rural infrastructure during 1999-2001: 1 987 km of roads, 2 531 km of embankments and excavated 1 487 canals.

FFW, VGD and RMP address equity issues. While FFW benefits women with income, RMP and VGD serve both women and gender issues by providing training, which creates awareness, enabling women to make decisions and undertake initiatives in any business.

TABLE 5
Projected economic internal rate of return: selected flood, drainage & irrigation projects

PROJECT NAME	DONOR	APPRAISALYEAR	EIRR (%)
Small-scale FCD Projects Small-scale drainage and flood-control project (SSD-FCP)	IDA	1979	35
Small-Scale Irrigation Sector Project (SSIP)	ADB	1980	20-40
BWDB Small Schemes Project	IDA	1983	15-22 (FCDI)
Small-scale FCDI Project (SSFCDIP)	IDA/IFAD	1983	25-40 (FCDI)
Medium-scale FCD Projects Drainage and Flood Control I (DFC-I)	IDA	1978	28-38
Drainage and Flood Control II (DFC-II)	IDA	1981	21-25
	IDA	1970	22
	IDA	1975	15
	IDA	1977	16
	ADB	1977	18
	ADB	1978	18

Source: MPO, National Water Plan Project, Second Interim Report, 1984, p.8.

Redesigned food-assisted rural development programmes address environmental concerns. For example, roads were previously constructed under FFW without culverts allowing fish-passes. As a result, FFW threatened fish production. Under the new programmes, culverts are built under FFW schemes as well. Food-assisted programmes are now combined with afforestation projects to enhance environmental protection and increase fish production (Mid-term Review).

Various donor-funded projects have increased the internal economic rate of return of selected FCD and FCDI projects (Table 5).

Level of project success/failure

The level of success or failures of land and water sector projects is influenced by varied factors including faulty design and time overruns leading to cost overruns. Some failures are attributable to poor management. Public sector-led minor irrigation development, which lasted until the early 1990s, provides examples of failed management. Thus, DTW and LLPs were formerly rented to farmer groups who were meant to pay seasonal rentals to BADC at a fixed rate. DTW rentals have always been in arrears; concerted efforts by managers to collect rents on schedule or to provide timely repair and maintenance service were lacking. A joint Bangladesh Government/World Bank study in the mid-1980s led BADC to phase out the rental system for irrigation devices in favour of a sales system.

However, where management is conscious and services to the farmers are satisfactory, rental systems can also work well in the public sector. For example the Barind Multipurpose Development Authority (BMDA) in northwest Bangladesh operates some 4 000 rental DTW units and rental recovery is over 95 percent. A similar project is managed by DAE in southern Bangladesh in which LLPs and power tillers are rented to farmers and recovery is satisfactory at about 90 percent.

Land reclamation and estuary control in coastal Bangladesh began in 1974. Until 1987 it concentrated on surveys, training and data collection, but some tangible success was achieved through building a pilot polder. NGOs helped organize landless farmer cooperatives, 30 of which took possession of the land allotted to them within the polder area in 1986. No follow-up action has been taken. This project cannot be measured in terms of economic benefits, which are outweighed by social benefits, evidenced by the fact that hundreds of landless families now have access to land.

People's participation

People's participation in project conception, planning, development and execution is vital to project success, but until the first half of the 1990s, such participation at all stages of project cycles did not take place. Beneficiary participation in project operation and maintenance developed in the mid-1990s. Many completed BWDB projects did not realize projected benefits due to a lack of funds for operation and maintenance. The question of cost recovery from the beneficiaries arose as early as 1963, but little or no cost was recovered from the completed projects.

Under the BWDB rehabilitation projects an initiative was taken to organize and develop Water Users Organisation (WUO). A three-tier system of water users was developed consisting of Water User's Groups (WUG), Water User's Committees (WUC) and Water User's Associations (WUA).

It was learned that groups are socially very heterogeneous. As in other countries in the region, effective organization for irrigation management through beneficiaries can be difficult to achieve and takes time (BWDB Systems Rehabilitation Project, 1994). This emphasizes the need to attend to social engineering aspects of project design and management.

PART II: HISTORICAL TRENDS AND PRIORITIES

Bangladesh public policy regarding investment and prioritisation in lands and water development was influenced both by (a) the compulsion to protect the country from the ravages of devastating floods and to attain self-sufficiency in foodgrains. The initial thrust centred on a public sector-led management approach, mentioned above. Emphasis was on large FCD and FCDI projects until 1972, when a comprehensive study on the land and water sector was conducted by the International Development Association (IDA) at the request of the government. This study drew attention to the

need for low cost irrigation systems by exploiting ground as well as surface water resources. That year some changes occurred in the institutional arrangement for water resource development. WAPDA was divided into two bodies, the Bangladesh Power Development Board (BPDB) and the Bangladesh Water Development Board (BWDB), the latter being exclusively responsible for major irrigation, flood control and related activities.

BADC took the lead and infused momentum in minor irrigation sector, while BWDB concentrated on FCD and FCDI projects. Privatization of the minor irrigation sector was addressed during the mid-eighties as already stated. In the first phase, the rental of minor irrigation equipment gave way to a sales system. In the second phase (after 1990), minor irrigation was left totally to the private sector and BADC withdrew from the procurement and sale of minor irrigation equipment. BADC was also required to sell its existing stocks in the godown and also those already operating in the field. This radical change from a public sector-led approach to private sector investment in the water sector was a difficult decision for the government. There were fears that such a radical change would impede growth in the minor irrigation sector.

Nonetheless, appropriate policy support for increased private sector involvement was provided by government which removed import restrictions (setting the approved brands and models of irrigation engines) and import duties and taxes. Public sector presence in minor irrigation, specially DTWs, was retained and coupled with integrated area development projects in the northwest through creation of a separate body, the BMDA.

In respect of large FCD and FCDI projects, BWDB retains its function as a public sector agency. There have been changes, however, in its approach to water sector investment. It has also opted for small-scale irrigation and drainage projects generally known as Early Implementation Projects (EIP). These are short gestation projects requiring smaller investment than the usual FCD or FCDI projects. A related development is the initiation of a National Water Plan during the mid-1980s. The objective was to assess total water demand in relation to availability for competing uses such as agriculture, fisheries, water transport and public health. Completion of the National Water Plan led to the birth of a new institution called the Water Resources Planning Organization (WARPO). Its development during the early nineties following the devastating floods of 1987 and 1988 focused attention on the need to develop a long-term strategy to cope with the complexity of flood impacts. With this thought in mind, the government prepared a flood protection programme and with the assistance of United States Agency for International Development (USAID) specialists carried out a flood policy study. Through this process a Flood Action Plan (FAP) was born, under which a number of studies were completed.

Development in the nineties led to a greater awareness of water resource planning and management and to formulation of a National Water Policy (NWP) to provide a policy framework for competing water uses and priorities. The NWP recognizes that shifting development needs requires a broader perspective to address the diversity of emerging demands on water resources and services. The policy also reflects the awareness that the wider social, environmental and institutional components of water sector management are not only important, but are central to achieving national goals.

Yet another development providing means to invest in land and water sector took place during the 1990s. The Local Government Engineering Department (LGED), primarily responsible for construction and maintenance of infrastructure in rural areas, initiated through foreign assistance some projects in water resource use centring on surface water. Other important developments during the late 1980s and 1990s include: creation of WARPO; strengthening research in surface water system through River Research Institute (RRI); and establishment of a Surface Water Modelling Centre (SWMC).

LONG TERM PLAN FOR LAND AND WATER

The first comprehensive attempt to develop long term plans for land and water was undertaken by the government during the mid-eighties through the creation of Master Plan Organisation (MPO) which later took permanent shape as WARPO, a multi-disciplinary water resource planning body set up under an Act of Parliament.

National Water Management Plan (NWMP)

The establishment of the National Water Council (NWC) during the mid-nineties was a step forward to ensure participation of all stakeholders in the preparation and adoption of National Water Policy (NWP) 1999. Based on the policy framework provided by NWP, the draft National Water Management Plan (NWMP) was prepared to contribute to overall national goals and to provide a framework plan to guide but not prescribe, in an integrated and comprehensive manner, the actions of all concerned with developing and managing water resources and services.

The NWMP is a rolling plan to be reviewed and updated every five years, providing a firm plan for the first five years, an indicative plan for the subsequent five years and a 25-year perspective plan for the long term, set in a projected context of what may happen in at least 50 years. The NWMP is realistic about the prospects for institutional and implementation capabilities, and seeks to rationalize and strengthen the institutional capacity of different stakeholders. It is intended to be of use to all agencies and organizations engaged directly or indirectly in the water sector (WARPO, 2001).

NWMP has developed and proposed a framework for a water management plan taking into account other sectoral and subsectoral policies, progressing steadily since 1992: the National Environment Policy (1992), the National Forestry Policy (1994), the National Energy Policy (1996), the National Fisheries Policy (1998), the National Policy for Safe Water Supply and Sanitation (1998), the National Agricultural Policy (1999), and the Industrial Policy (1999).

The draft NWMP notes that these policies in conjunction with the NWP provide an extensive framework for management of the water sector with no apparent major contradictions. It further notes that the main policy gap is in land use planning and the lack of an integrated transport policy, which has a bearing on navigation. However, it must also be noted that the policy framework provided by NWP has taken into account the needs of water transport including navigation and zoning of land for industrial use. It is expected that other related issues having relevance for land use planning will be taken into account based on the Land Policy which has now been finalized.

In preparing the NWMP, the future development challenges have been considered. The socio-economic challenges include population growth, urbanization, poverty alleviation, economic growth and development, and employment generation.

Population growth: Total population will increase by 37 percent from 132 million to 181 million by 2025, and 224 million by 2050.

Urbanization: Urban population will grow to 73 million (40 percent) by 2025, and to 136 million (60 percent) by 2050.

Poverty alleviation: Fifty-seven percent of the population in rural areas and 51 percent of the urban populace is poor.

Economic growth and development: Growth rates of 5.5 to 6 percent are projected over the next 25 years. Fourteen million new jobs will be needed by 2025 plus a further 21 million by 2050.

Democratization and development: Demand is increasing for full consultation and participation in all sectors.

Education and public health: Major efforts are required in education and public health with urgent attention to arsenic contamination of aquifers.

Food security: Maintaining rice and protein security will require yield improvements and agricultural intensification, particularly as agricultural land per capita is expected to markedly reduce.

In addition, it has also identified common water related issues and region specific issues (see Box 1). It is noted that many proposed actions relate to investment in land, specifically including: preservation of the Sundarbans; maintenance of coastal embankment system; flood proofing needs of accreted (char) lands and low lying areas; protection of newly accreted land and their development; and erosion in the major rivers.

The NWMP has also drawn attention to technical knowledge gaps. Significant challenges exist in dealing with river maintenance, erosion control, land accretion and coastal management. It has proposed research on implications and responses regarding climate change, including:

Arsenic: Assessing the current and future extent of contamination and the implications for food safety of irrigating with arsenic contaminated water;

Groundwater utility: Understanding how quality affects groundwater utility and the long-term strategic implications.

Natural environmental water requirements: Understanding the relationship between water and the natural environment and establishing key indicators and thresholds for environmental health and sustainability.

Long-term implications for water management: Promoting dialogue among riparian countries and developing appropriate long-term strategies in response to increasing demands on the system.

Devolved and decentralized water management: Determining the most appropriate models.

Promotion of private sector participation: Assessing how best to promote participation in major infrastructure development and management.

Recent approaches to investment in the water sector are holistic, encompassing all sectors of the economy. Research on water, and with it land and environment has been emphasized. This reflects a change in priorities from the brick and mortar approach that dominated previous investment decisions in water to one more consonant with national goals and future development challenges.

Funding the National Water Management Plan

The overall capital cost of the NWMP has been estimated to be a little over one trillion Taka or US$20 billion, distributed between eight clusters as shown in Table 6.

It is intended that these costs will be funded by a combination of traditional government allocations from Gross Domestic Product (GDP), beneficiaries, small-scale private sector and other sources. Other sources will include larger private sector instruments, public bond issues and water and environment funds, but will be highly dependent on the emergence of the enabling environment.

Inadequate provision for recurring is recognized as a major constraint on sustainable water sector management. The plan will facilitate increased cost recovery based on user pays principles and transferred responsibilities for scheme operation and maintenance. Furthermore, although the recurring costs will build up to considerable amounts by the end of the plan's lifetime, the greater part of them will comprise service fees that can be sanctioned. In due course, and based on consultation and sensitization over a suitably protracted period, other recurring costs will gradually become the responsibility of users – leaving government with a small residue of recurring costs that it should rightly cover.

BOX 1

PRINCIPAL WATER-RELATED ISSUES IN BANGLADESH

Common issues: urban and rural services, environmental management and pollution control; local drainage and water management facilities; and arsenic contamination.

South West Region: preserving the Sundarbans; restoring dry season freshwater inflows; maintaining coastal embankment system; alleviating coastal drainage congestion; Improved cyclone protection; Remedial actions for existing FCDI schemes; floodproofing needs in charland and low-lying areas

North East Region: environmental management of Haor Basin; remedial actions for existing FAC schemes; floodproofing of villages in Haor Basin; erosion of old Brahmaputra left bank; drainage congestion in the kalni-kushiyara and other rivers; local development of the irrigating

North Central Region: bulk water supplies and pollution cleanup for Dhaka; flooding and drainage problems; floodproofing in the charlands and low-lying areas

North West Region: right bank erosion of Brahmaputra; flooding, drainage problems; remedial measures for existing FCD(I) schemes; drought in western fringes; flood proofing needs in charlands and low-lying areas

South Central Region: maintenance of the existing coastal embankment system; salutation and drainage congestion; improved cyclone protection; flood proofing charlands and low lying areas

South East Region: gaseous aquifers; improved cyclone protection; maintenance of existing coastal embankment system and drainage congestion; protection of newly accreted lands against tidal flooding and their development; remedial action for existing inland FCDI schemes

Eastern Hills Region: small-scale irrigation development in CHT; mini-hydropower development in CHT; improved cyclone protection in CFCP; maintenance of existing coastal embankment system

Rivers and Estuary Region: affordable long-term strategy for erosion protection; affordable long term strategy for regional augmentation; floodproofing needs in charlands and low lying areas; improved cyclone protection in the Meghna Estuary; erosion of Meghna River; timely protection of newly accreted lands.

The Special Programme for Food Security

With assistance from FAO and other donors government implemented a Special Programme for Food Security (SPFS) with three components: intensification, water control and diversification. As part of the intensification component the programme will develop soil testing and analysis based on soil test kits. This activity is correlated with a programme of sample soil analysis in soil laboratories. Farmers and extension staff will be trained to use field test results to determine fertilizer needs. Crop recycling and rotation and the use of biomass compost and farmyard manure will be promoted. In addition, farmers in the pilot area will be encouraged and trained to undertake integrated pest management.

The results of the on-farm water management pilot programme in support of SPFS were encouraging. The irrigation command area has been increased by some 20 percent. Training programmes under the project have helped extension personnel and participatory NGOs in their capacity building and in developing knowledge and skill in improved water management and crop production technology. The major innovations introduced through this programme include: (a) delineation of manageable irrigation and drainage channels, (b) irrigation scheduling in accordance with crop water requirements and (c) supplementary irrigation for rainfed rice crops. This has had a demonstration effect; neighbouring villages have learned the usefulness of supplementary irrigation, which is vital for Aman rice in drought prone areas. Research showed that with supplementary irrigation in drought-prone districts (2.8 million ha), increased yields of 20 to 30 percent can be achieved.

TABLE 6
Overall capital cost of the Bangladesh National Water Management Plan (NWMP)

Cluster	Estimated Cost in Billion Taka (mid-2000 prices)			Percentage of Overall NWMP		
	Short Term	Medium Term	Long Term	Residual	Total	Budget
Institutional Development	5.71	5.99	7.76	0.48	19.94	1.98
Enabling Environment	0.88	0.89	1.70	0.20	3.67	0.37
Major Rivers	10.88	29.50	152.78	35.22	228.38	22.70
Towns and Rural Areas	28.87	70.96	152.57	8.49	260.89	25.94
Major Cities	25.84	106.57	254.39	14.51	401.40	39.89
Disaster Management	6.40	7.83	12.30	0.54	27.17	2.70
Agriculture and Water Management	4.25	7.67	27.48	6.47	45.87	4.56
Environment and Aquatic Resources	3.67	5.47	9.07	0.50	18.71	1.86
Total	**86.50**	**234.88**	**618.15**	**66.41**	**1 005.94**	**100.00**

Source: National Water Management Plan,Ministry of Water Resources,Government of Bangladesh, July 2001.
Note: ST = short-term; MT = medium-term, LT = long-term.

PART III: PRIVATE INVESTMENT IN LAND AND WATER

Discussion will now be made on (a) how private investment in land and water has grown independent of project support/area, (b) what are the perceived impediments to private investment and (c) in what areas and at what level a complementarity can be established between public and private investment on land and water.

How private investment has grown

In its simplest form, private investment in land and water has been driven by the struggle for survival. The level of investment started to increase as the demand for food crops, fish and meat increased with population growth. It has also been supported by policies adopted by the government from time to time. These measures initially included credit support for crop production. The advent of the Green Revolution in the 1960s resulted in higher productivity per land unit, while water demand for irrigation and additional crops increased. Large-scale FCD and FCDI projects required heavy investment and technical support at levels unattractive to the private sector. However, policy changes in the minor irrigation sector which led first to the change from rental to sale system and then withdrawal of import restrictions, gave further impetus for private investment.

The magnitude of private investment by farmers in the minor irrigation sector can be seen from the historical trend in the use of various types of irrigation pumps (Table 7).

Until 1989 there were restrictions on the import of STW and LLP. Only standardized makes and models approved by the Standardization Committee of the Ministry of Agriculture could be imported. When the restrictions were withdrawn, investment by farmers in equipment purchase increased significantly. It is significant that investment in DTW did not keep pace with STWs and LLPs primarily because of the high cost relative to other two types of equipment. Investment in minor irrigation is closely related to rice prices, in particular a rainfed rice variety called Aman (National Minor Irrigation Census, 1999-2000).

Performance in regard to investment in agriculture and water resources (Table 8) indicates that private investment is lowest in the forestry sector, followed by that of water resources. In all other cases, private investment is much higher than public investment. As explained, the relatively low level of private investment in water resources is largely due to the need for large amounts of funding. Limited private investment in commercial forests, however, is primarily due to the lack of available land plus the fact that the idea of commercial forestry as a business has not yet taken root in Bangladesh.

On the other hand, rising national demand for fish, poultry and dairy products – and in some cases export potential – has led to higher investment in these subsectors. The number of dairy farms rose from 26 000 in 1994-1995 to 33 000 in 1999-2000, while 76 000 poultry farms in 1994-1995 rose to 106 000 in 1999-2000 – all private sector led investments. Much of this can be explained by public policy factors conducive to business growth: first, government (through project intervention) provided necessary credit and technical support to develop agro-based industries; second, selected entrepreneurs were provided facilities and exposure to necessary technologies; and third, business incentives (lower tariffs or tax-free status, tax holidays and other concessions) encouraged growth.

On the other hand, rising national demand for fish, poultry and dairy products – and in some cases export potential – has led to higher investment in these subsectors. The number of dairy farms rose from 26 000 in 1994-1995 to 33 000 in 1999-2000, compared to 76 000 poultry farms in 1994-1995 increasing to 106 000 in 1999-2000 – all private sector led investments. Much of this can be explained by public policy factors conducive to business growth: first, government through project intervention provided necessary credit and technical support to develop agro-based industries; second,

selected entrepreneurs were provided facilities and exposure to necessary technologies; and third, business incentives (lower tariffs or tax-free status, tax holidays and other concessions).

However, project intervention had only a demonstration effect. Major investment in these sectors has been generally independent of any project support being driven mainly by market demand and an attractive return on investment. Government established an infrastructure development company (IDCOL), which currently provides subordinated or junior loans for investment in infrastructure and utilities. IDCOL is examining the possibility of diversifying its products; if found appropriate loans could be provided for private sector investment in land and water. IDCOL, however, needs additional resources to continue its operation (Memorandum for Bangladesh Development Forum 2000-2001).

TABLE 7
Operational equipment by season 1982/83 to 1999/2000

IRRIGATION SEASON	ANNUAL OPERATING EQUIPMENT ('000 UNITS)			ANNUAL PERCENTAGE CHANGE		
	STW	DTW	LLP	STW	DTW	LLP
1982/83	93.1	13.8	35.5			
1983/84	120.3	15.5	36.0	29.2	12.3	1.4
1984/85	147.0	16.9	37.0	22.2	9.0	2.8
1985/86	146.0	17.9	37.5	-0.1	5.9	1.4
1986/87	160.3	18.7	40.6	9.1	4.5	8.3
1987/88	188.7	20.3	42.3	17.7	8.6	4.2
1988/89	235.9	22.4	50.8	25.0	10.3	20.1
1989/90	260.0	22.6	51.0	10.2	0.9	0.4
1990/91	270.3	21.5	51.6	4.0	-4.9	1.2
1991/92	309.3	25.5	50.3	14.4	18.6	-2.5
1992/93	348.9	25.7	52.2	12.8	0.8	3.8
1993/94	359.2	24.5	52.6	3.0	-4.7	0.8
1994/95	488.9	26.7	57.1	36.1	9.0	8.6
1995/96	576.2	27.3	60.6	17.8	2.2	5.1
1996/97	629.8	25.2	62.9	9.3	-7.1	3.6
1997/98	664.7	25.3	66.3	5.5	0.6	5.4
1998/99	736.1	26.7	72.9	10.7	5.3	10.1
1999/00	757.1	25.1	71.6	2.9	-6.0	-1.8

Source: DAE, National Minor Irrigation Development Project, Minor Irrigation Census, 1999-2000.
Note: 1982 to 1993/94 data from Census of Irrigation in Bangladesh, ATIA

Risks in investment in land and water

The private sector investment in land and water, specially land should be judged in terms of risks associated with such investment from environmental and other considerations. One of the major risks, which are not particularly confined to private sector investment, is the rapid urbanization process and increasing demand for rural roads and other infrastructure for which public investment has to be made. Added to the above is the demand for more lands for housing, specially in the peri-urban areas. In these areas, private sector has shown increasing interest and has started increasing investment in real estate development. The combined effect of all these coupled with loss of land due to river erosion has led to a sharp decline in the total area of arable land. This is a matter of concern since the annual loss of cropland is estimated at 80 000 ha. This underscores the need for greater investment in land reclamation programmes and zoning of land with supportive provisions for industry and non-agricultural purposes.

TABLE 8
Projected investment in agriculture and water resources 1997-2002

Sectors	Public	Private	Total
Crop Agriculture	21.43 (0.50)	65.04 (1.52)	86.47 (2.03)
Fisheries	5.86 (0.14)	21.84 (0.51)	27.70 (2.03)
Livestock	5.44 (0.13)	20.64 (0.48)	26.08 (10.61)
Forests	6.98 (0.16)	4.73 (0.11)	11.71
Water Resources	73.37 (11.72)	7.34 (10.17)	80.71 (1.89)
Total	113.08 (2.65)	119.59 (2.80)	232.67 (5.45)

Source: Fifth Five-Year Plan, 1997-2002, Planning Commission, Ministry of Planning, Bangladesh
Note: Figures in parentheses are billion US$ at 1996-1997 exchange rate. i.e. US$1 = Taka 42.70.

Impediments to private investment for land and water

The major impediments to private sector investment on land and water may be discussed. In respect of land the major impediments are uncertainties or vagueness in respect of landownership, which lands the investors in problems of litigation. A related problem is the fear of acquisition of land by the government in public interest. Absence of provision of credit for purchase of land is another obstacle to invest in land. While these impediments would be applicable for investment in land for industrial purposes, investment in land for agricultural purposes is primarily impeded by atomized nature of plots of lands. According to the latest Agricultural Census (1996) out of 11.8 million households, 80 percent belongs to smallholdings defined as an area from 0.5 to 2.49 acres.

In respect of the water sector the major private investment is mainly done in wetlands and the prevailing system of leasing out the right to fishing needs to be vastly improved in terms of the length of the lease period and other terms and conditions. In the wetland locally called haors and baors there

is a conflict between those who wishes to promote fisheries and those who have interest in producing rice. Unless this conflicting demand is satisfactorily solved large-scale investments in these areas will not be forthcoming. While this would apply to investments for fisheries sector, major impediment to irrigation is the requirement of capital for FCD and FCDI projects. The levels of investment are high and it will continue to remain within public sectors.

Complementarity for private and public investment in land and water

The NWP provides a policy framework to establish levels of complementarity for investment by public and private sectors. The strategic elements include: coordinating public and private sector stakeholders; associating beneficiaries and protecting their water management interest; transfer operation and management (O&M) responsibility of projects with command areas of less than 5 000 ha to beneficiaries responsible for O&M from their own resources; transfer operation and management responsibility of projects exceeding 5 000 ha by private sector contract (through open competitive bidding). Alternatively, the executing agency may jointly retain management responsibility with local government and beneficiary groups; transfer FCD and FCDI projects with a command area of 1 000 ha to local government institutions by phases; provide training and information to the private sector and beneficiary groups for capacity building in efficient water management.

PART IV: CONCLUSIONS

The discussion on land and water sectors lends itself to several conclusions. In Bangladesh investment in land and water has a symbiotic relationship. Investment in the water sector, especially those relating to land reclamation, development and management of accreted land, prevention of river erosion, construction, repair and maintenance of coastal embankments etc. directly and indirectly contribute to land development and also conduce to greater productivity as (a) additional lands are available and (b) loss of land is prevented. Investment in FCD and FCDI projects similarly help in either preventing crop losses and/or contributing to higher productivity through irrigation.

Bangladesh has a long history of investment in land and water, primarily led by public sector organizations, dating back to 1959. Policy shifts in management approach for land and water development projects and programmes have occurred since then. The major policy shift has been in respect of minor irrigation centring on the use of pumps (1989), which allowed greater opportunities for investment by the private sector, primarily farmers themselves.

While investment and management in minor irrigation is now exclusively privatized, major irrigation (FCD and FCDI projects) continues in the public domain primarily due to the level of investment and technical expertise required for its operation and management. The policy framework adopted through the NWP nonetheless provides opportunities for private and local government institutions to own and operate water development programmes not exceeding 5 000 ha command area. For those exceeding 5 000 ha, NWP permits private sector investment in operating and managing such programmes under lease and management contract. The proposed diversification of products by IDCOL is expected to further expand and strengthen opportunities for such investment provided necessary resources are made available to it.

Impact of soil and water development on poverty alleviation, employment generation, income augmentation and food security has been positive in more ways than those herein discussed. In Bangladesh, it is all the more so because of the nature and size of farms, 80 percent of total rural farms do not exceed one hectare. Due to continued investment on land and water, food availability on a per capita basis increased from 433 grams in 1995-1996 to 534 grams in 1999-2000.

The recent policy changes as reflected in the NWP providing for greater opportunities for the private sector is firmly rooted in the experiences gained in the past in respect of operation and maintenance of successful and unsuccessful projects. The lessons learnt from successful and unsuccessful projects have led the government to adopt a holistic approach to land and water development in order to provide much greater benefit to the society as a whole than was possible in the past with fragmented approach in these sectors.

The holistic approach with long term development plan as reflected in the NWMP is expected to minimize social, environmental and other associated risks in land and water development programmes. The provision of review of the plan every five years has been consciously made for keeping the implementation process under close and constant review and providing scope for appropriate adjustments in the greater interests of all stakeholders.

Two major areas of concern remain to be addressed. First, in Bangladesh context the continued decimation of arable land through rapid urbanization, development of infrastructures in both urban and rural areas call for much higher level of investment on land and water than is available. The investment programme delineated in NWMP will remain meaningless unless it is backed by appropriate level of funding. The second concern, which is linked to the first, is the declining level of official development assistance (ODA) to developing countries in agriculture sector. The incremental requirement of investment in the sector of such countries are estimated at about US$31 billion per annum of which approximately one-third is required for investment in irrigation. Investment in land and water has long lasting effects in terms of ensuring food security: making opportunities for the poor to have access to better standard of living, preventing environmental degradation, reversing the declining trend of ODA for these sectors will be a step towards achieving the objectives agreed at the WFS in 1996 by world leaders and will be a step away from a hungry and malnourished world.

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Investment in land and water in Cambodia

INTRODUCTION

Cambodia is bordered by Thailand in the west and by Laos and Thailand in the north, by Viet Nam in the east, and by the gulf of Thailand in the south (Figure 1). The total land area is 181 035 km^2, consisting of 24 provinces, including two municipalities and 172 districts. Forest areas cover 12.1 million ha or 67 percent of total land area. The cultivated area is 3.78 million ha or 21 percent excluding land mine areas (Table 1). Rice cultivation in 1999 was 2.08 million ha, or 91.2 percent of total cultivated areas.

Population is currently estimated at 12 million, growing at annual average of 2.8 percent and with a population density of 51 persons/km^2. It is a notable sex imbalance: 52.2 percent are female and 47 percent male, and a high proportion of are in younger age groups because of decades of conflict. The current per capita GDP (US$290) is considered one of the lowest in the world. The agricultural sector is Cambodia's top earner in the national economy, accounting for 75 percent of all employment and 45 percent of the GDP in 1994. Cambodia is a rice-producing and exporting country with favourable natural conditions for paddy cultivation.

The overall goal of the Royal Government of Cambodia (RGC) is poverty eradication through socio-economic development. Thirty-six percent of the population is estimated to be below the poverty line. Strategies for attaining these goals focus, among other things, on improved access to public services, provision of safe drinking water and sanitation (particularly in rural areas), improved infrastructure and increased agricultural productivity to achieve food security. The water sector helps achieve many RGC development goals. Irrigation supports agriculture, and therefore the achievement of food security, poverty reduction and socio-economic development. Water supply and sanitation meet the needs of the urban and rural populations, as well as their health requirements, and contribute to the achievement of better living standards. Drainage and sewerage support improved health and living standards while hydropower development aims at socio-economic development. Inland navigation moves goods and passengers from one place to another, and facilitates tourism. In general, water contributes to the livelihood and food supply of the population by providing fish, animal protein and aquatic plants.

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Under Article 59 of the 1993 constitution, "the State shall protect the environment and balance of abundant natural resources and establish a precise plan of management of land, water, air, wind, geology, ecological system, mines, energy, petrol and gas, rocks and sand, gems, forests and forestry products, wildlife, fish and aquatic resources". By this provision the state recognizes the value of natural resources, including the resources of water and land, as strategic for the country's development and the enhancement of the welfare of the people.

TABLE 1
Land use and cultivated areas in Cambodia

Land Use Group	Area (ha)
I. Natural Area	**12 000 200**
A. Forest	6 283 400
1. Mainly evergreen forest	4 816 000
a. Broad leafed forest	361 700
Dense broad leafed forest	61 400
Flood evergreen forest	528 900
Mangrove forest	
Mosaic of evergreen or deciduous forest and secondary vegetal formations	157 200
Mosaic of flooded forest, swampy vegetation, fallow land	358 200
Secondary vegetation	9 800
b. Pine forest (P. merkusii)	
2. Deciduous forest	6 007 000
B. Other vegetation	**1 529 200**
Thickets	95 600
Scrub, brushwood	102 600
Grass savannah	129 000
Grassland susceptible to flooding	822 900
Swampy vegetation	379 100
II. Cultivated areas	**3 785 000**
Paddy field	1 377 100
Paddy field with palm trees	1 309 200
Mosaic of upland crops and secondary vegetal formation	839 400
Mosaic of field crops and fruit garden/rural area in the lowland	174 400
Plantation (rubber)	84 900
III. Other land usages	**539 100**
Bare land and sandy banks	51 500
Open water areas, rivers	487 600
TOTAL	**18 153 500**

Source: Data from Irrigated Agriculture Department, Ministry of Water Resources and Meteorology (MOWRAM)

PREVIOUS DEVELOPMENT OF WATER RESOURCES AND LAND

Ancient history

From time immemorial, water management has been a primary concern for the Khmer people. Agricultural production, central in the economy of our early civilizations, relies on it. Due to irregular patterns of rainfall with dry spells during the growing season, the annual inundation and variations in micro relief, water management is quite difficult and, depending on local circumstances, varied methods have been developed since the earliest emergence of Khmer civilization. Numerous varieties of rice well adapted to differing local conditions were developed.

Three types of farming can be distinguished:

Floodplain farming: These farmers grow broadcast rice watered by natural flooding in two major floodplain areas from the first centuries of Cambodia's history. One is today's Korat plateau in northeast Thailand, while the other is the Mekong River delta, now mainly in Viet Nam. Settlements were characterized by year round availability of water, ease of land reclamation and a gentle flood regime. In those days, water resource development basically meant digging additional ponds, canals and moats. Some are quite large, even by today's standards. They often had multiple functions: serving as reservoirs for domestic use, supplementary irrigation in dry periods, stock and fish breeding and transport. By the tenth century, these locations were almost entirely abandoned, perhaps because of a change in the flood patterns or because of security reasons in the delta when pirates attacked settlements.

Bunded field farming: This practice was developed from the eighth century onward by reclaiming lowland forest into small bunded fields. It is estimated that more than 50 million bunded fields existed in the Angkor period. Agricultural and water management practices developed strongly and became much more labour intensive during that time. Rice is no longer sowed directly but is transplanted from nursery beds; fields are levelled. Many methods have been developed to distribute, retain and retard water during the rainy season or floods, including building small bunds or dams across valley floors of small streams (without reaching the sides of the valley) and digging ditches or building bunds parallel to main streams to trap receding waters or to store water flowing in from tributaries or adjacent areas.

Receding flood farming: Depending on local circumstances, the micro relief with depression, levees and tributaries, a great diversity of sophisticated receding flood farming practices have been developed in the floodplains of Cambodia. Water from the preceding flood and tributaries is retarded and spread laterally by bunds, small dams, dykes, ditches and stored in bunded fields, natural depressions and swampy areas or in various types of man made reservoirs. After the rainy season, supplementary watering is achieved by gravity from reservoirs or tributaries using ditches and/or simple water lifting devices. Often, rice is grown in the upper parts of the depression or reservoirs and water plants in the deeper parts.

Present methods of development

The methods described above are still widely practised in Cambodia. Intake and diversion structures, canals for the transport of irrigation and drainage water, and organization for operations and management.

Angkor Wat and super irrigation schemes: From the seventh to the thirteenth centuries a great civilization, called Angkor Wat (after its capital) developed near Tonle Sap, the Great Lake. To create a replica of heaven, walls, temples, roads and city moats were oriented according to

cosmologically ideal directions, i.e. North-South and East-West, and so were their often huge rectangular ponds. After discovering the ruins of Angkor in the jungle, the French began restoration and the remains of this great past became the basis of a great national myth. The myth suggests that Angkor's ancient system of moats, ponds and canals, formed a 'super' irrigation system which not only was the basis for its rice-cultivation based wealth but that it also cannot be surpassed by contemporary water wisdom.

Recent history, the Sihanouk period (1953-1970): Inspired by the example of Angkor, Prince Norodom Sihanouk vigorously promoted upgrading water management, and self-help projects were planned and carried out countrywide by the local population under the supervision of local civil authorities or Buddhist monks. Little knowledge was required to rescale traditional structures into larger ones, using concrete instead of wood and woven rattan. Many reservoirs in the floodplains were formed by constructing dams. Traditional dams are low, overtopped by the slowly rising flood. Higher dams require intake structures able to be closed and a crest level above peak flood, because overtopping waters will cause too much damage to be repaired during short operating periods. Following establishment of the Mekong Committee in 1957 many project locations for large-scale dams were identified in the 1960s. A cascade of large hydropower dams, mainly in combination with irrigation schemes (up to 200 000 ha) was planned in the mainstream and major tributaries. Most of these projects hardly reached the feasibility phase. In Cambodia only the Prek Thnot project (about 70 000 ha) had been initiated before the war broke out in 1970.

FIGURE 1
Map of Cambodia and irrigation locations

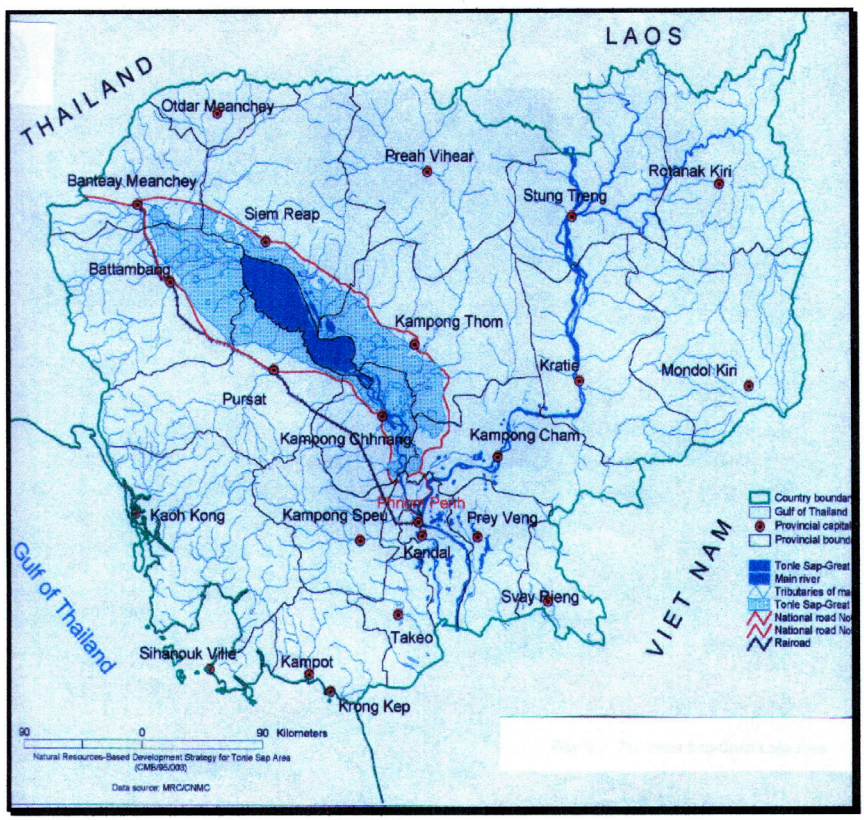


Figure 1: Map of Cambodia and Irrigation Locations

The Khmer Rouge period (1975-1979): As during the Angkor Wat period, rice became the state's economic basis under the Khmer Rouge regime. Almost the entire population was forced to grow rice during the wet season and to construct water management and irrigation systems during the remaining five to eight months of the year. The country was to be turned into a super irrigation system, to become independent of rainfall. Those few persons with the required technical knowledge had either fled, been killed or were not consulted during this process. Prompted by the Angka, the polittcal centre of the Khmer Rouge, irrigation canals were not laid-out according to contour lines, but on the coordinates which were drawn on most 1:50 000 scale topographical maps. As a result, canals from this period are situated in North-South or in East-West directions having a distance between them of one kilometre. In this way a chessboard of canals was formed. Due to the inclination of the terrain, sections of these canals often slope in different direction than other sections.

Present situation: Today, more than 20 years after the Khmer Rouge regime, it is clear that only a small percentage of these structures can be incorporated in any future water management system, and they will require much additional investment. Most of the structures are useless or, even worse, disruptive to water management.

THE ROLE OF WATER IN THE AGRICULTURE OF CAMBODIA

Government social-economic development requirements and proposals make several references to water resources and their management. Water is seen as contributing to Government priorities including poverty alleviation and economic growth principally as irrigated agriculture, seen as essential to addressing poverty by achieving food security and promoting income generation in rural areas. The importance of water is recognized also in the context of water for irrigation. Government proposals for public sector investment allocate about 22 percent of projected investment funds to the irrigation sector.

Rural agriculture dominates the Cambodian economy, accounting for nearly half of the gross domestic product and 90 percent of employment. Consequently, water policy as a whole and irrigation in particular, are significant factors in the development of agriculture leading to food security, poverty alleviation and commercialization. Today, the irrigation has been made available to only 16 percent of total cultivated area (Tables 2 and 3). Available data reveal that the country is using only 1 percent of its total water resources of which 82 percent is in agriculture. Double cropping in full or partial control irrigation schemes is minimal. Production in irrigated rice yields is too low – averaging some 2 tonnes/ha. Irrigation rehabilitation and construction are thus priorities set by the Royal Government of Cambodia and the active involvement of user farmers is deemed essential at every stage and level.

Rice ecosystems

The International Rice Research Institute (IRRI) has defined four main ecosystems, three wet season and one dry season. The wet season systems compare: upland or mountain (2 percent), rainfed lowland (85 percent), including land with supplementary irrigated area, and deepwater/floating (4 percent). In the dry season (9 percent), the crop is fully irrigated or grown with supplementary irrigation either in deep flooded areas or on land exposed by the receding flood.

Wherever possible, supplementary irrigation is given during periods of low rainfall. Some modern varieties are grown in shallow water, but medium- and deeper-water rice varietes, accounting for 80 percent of lowland rice, are exclusively traditional. These traditional varieties will yield even if planting is delayed until September by late arrival of the monsoon, being photosensitive at reduced levels.

TABLE 2
Total rice harvested and irrigated areas, 1999

Province	Harvested Area, 1 000 HA			Irrigated Area 1 000 ha
		Wet Season	Total	
Banteay Mean Chey	140.2	0.3	140.5	36
Siem Reap	181.08	10.0	191.08	25.5
Preah Vihear	16.911	-	16.911	0.3
Stung Treng	13.466	-	13.466	0.8
Ratanakiri	17.618	-	17.618	0.2
Mondulkiri	6.180	-	6.180	0.2
Kratie	20.617	6.0	26.617	12
Kompong Thom	99.164	1.8	100.964	37
Battambang	168.571	1.2	169.771	52
Pursat	71.950	0.1	72.05	26
Kompong Chhnang	83.066	9.9	92.966	22
Kompong Cham	167.243	30.0	197.243	30
Svay Rieng	162.318	9.0	171.318	20
Prey Veng	240.225	57.0	297.225	40
Kandal	42.674	45.0	87.674	20
Takeo	173.131	58.0	231.131	40
Kompong Speu	84.303	1.0	85.303	22
Koh Kong	7.272	-	7.272	0.6
Kompot	133.107	2.5	135.607	19.3
Kompong Som	9.5	-	9.5	
Phnom Penh	5.396	1.2	6.596	3.1
Total	**1 843 992**	**233**	**2 076 992**	**407**

Source: Irrigated Agriculture Department, MOWRAM

Deepwater (floating) rice is grown where the water depth exceeds about 80 cm (up to 400 cm) in flooded areas around the Tonle Sap and in depressions along the Mekong River, mainly in Kampong Thom, Kompong Cham, Prey Veng and Takeo provinces. Most deepwater crops are dry seeded in April/May with seeds germinating with the onset of the rains. The depth and duration of flooding is dependent upon local rainfall and/or the height of the Mekong River. Areas may remain flooded for three to six months.

Dry season rice may be grown either as a fully irrigated crop at the end of the wet season, or in flood recession areas, normally with supplementary irrigation. Dry season rice is also now being planted in deep flooded areas in place of the more risky and lower yielding floating rice, that is grown in the wet season. Under these circumstances supplementary irrigation is normally provided. Mostly modern varieties are used, and yields are significantly higher than for the wet season crops.

TABLE 3
Implemented irrigation methods in Cambodia (1999)

Method	Irrigated area, ha	
	Wet season	Dry season
Gravity	87 800	119 700
Pump Station	19 350	23 650
Mobile Pump	73 850	47 850
Traditional Lift	23 000	11 800
Total	**204 000**	**203 000**

Source: Irrigated Agriculture Department, MOWRAM

REFORMS TOWARD PARTICIPATORY WATER MANAGEMENT

After nearly three decades of war and civil strife, the Cambodian economy continues to be affected by a legacy of turmoil. Agriculture is the backbone of the Cambodian economy, and it depends on irrigation – supplementary irrigation for wet season crops and full irrigation for dry season crops. Most existing systems were damaged by natural deterioration due to inadequate finance to support forming Farmer Water User Communities (FWUC) to operate and maintain irrigation systems: government and donors (the Asian Development Bank and others) are not funding FWUC formulation.

The former General Directorate of Irrigation, Hydrology and Meteorology established a national policy called Circular No. 1 (hereafter termed CN1) on implementing policy for sustainable irrigation systems without testing and development due to a lack of financial resources. In 1999, the Ministry of Water Resources and Meteorology (MOWRAM) was established, and it collected reactions to CN1 from farmers and NGOs, The ministry then organized two workshops – a regional workshop at Battambang for northwestern provinces and a national workshop in Phnom Penh – to assess participatory irrigation management and sustainable irrigation development, to develop CN1 and support documents. The ministry established a steering committee including all concerned MOWRAM senior technical officers a members chaired by the ministry Under Secretary of State. The committee reviewed CN1 to clarify and disseminate information to stakeholders. After endorsement and approval by the Minister of Water Resorces and Meteorology, creation of a Prakash 306 took place. Currently, Prokash 306 is endorsed, approved, issued and used for formulation the FWUCs.

Today, the Ministry of Water Resources and Meteorology need the resources to implement Circular No.1 and Prakash 306 in existing irrigation systems by forming FWUCs and support operation and maintenance costs for the first phase of five years. These are aimed to experience in providing a greater role for empowerment of autonomous and self-reliant FWUCs. Other purposes are to make sure on transfer of authority over management and financing irrigation systems.

CORE CONSTRAINTS IN WATER MANAGEMENT

A major constraint on crop production is substantial seasonal and year-to-year differences in water availability, which severely limits the ability of rural households to consistently provide for their own food needs, much less grow crops for sale. This is due to problems in water management in Cambodia, including the abundance of water in the wet season and its shortage in the dry season. In the wet season, the main tasks of water management include additional water for supplementary irrigation, controlling, regulating, and managing floods to protect human lives, property and crops. In the dry season, available water resources must be shared, for instance, between domestic use, irrigation, navigation, fisheries, livestock and forestry.

A Mekong River Commission assessment of some irrigation systems built during the Khmer Rouge period noted that at least one big dam was built on each tributary of the Mekong, Bassac and Tonle Sap. These dams had dual functions, e.g. to store water and to act as regulation structures for the chess board irrigation schemes. Often they were located in the flat lowlands of the tributaries and cause long lasting inundation with a negative impact on agricultural production. Most have since been flushed away, or the river has eroded a new riverbed next to the dam. In the flood plains, especially around the Great Lake, many canals have been dug towards the lake, but instead of providing irrigation, they serve to drain water, and at velocities which cause erosion. Much back swamp forest has been turned into rice fields – with a negative impact on fish production. Most hydraulic structures failed because of design defects such as: 1) erosion and scour (no stilling basin, soil protection or cut-off walls were applied), 2) structural problems (concrete structures lacked rebar or rebar was placed in

the wrong place, concrete was of poor mix, earth was not compacted and the base was not stripped), and 3) hydrology complications (in all known sluices the apron was too high and the width too small for the peak flood).

Almost no trained managerial personnel, means, capable organizations or databanks are present: a problem that is most strongly felt at provincial and lower levels. Compared to the need, the capacity of governmental organizations is far too weak, which results in a continued struggle in the field of water management. Farmers still using traditional water management methods are as dependent on the irregular rains as in the past and are often confronted with new problems associated with an altered water environment. Attempts to improve the situation (mostly requested by the farmers themselves) often fail and many recently built structures will collapse within a few years if they have not already done so. Why is this so? The only examples known by the responsible builders are the structures in their own neighbourhood or their own familiar methods and no other sources of knowledge are available. As a result, mistakes of the past are frequently repeated while improvements are achieved in a laborious trial and error process.

TABLE 4
Rice cultivated areas by rice ecosystems (1999) and calendar

Rice Type	**Harvested Area (ha)**	**Sow**	**Harvest**	**Yield (t/ha)**	**Production (t)**
Wet Season					
Upland	48 138	May	October	1.4	67 393.2
Rainfed Lowland:					
- early	371 553	May	end October	1.6	594 484.8
- medium	838 237	May/June	December	1.8	1 508 827
- late	529 495	June/July	January	1.7	900 141.5
Deepwater	56 569	April/May	Feb/March	1.3	73 539.7
DRY SEASON		Jan./Feb.	April		
Irrigated and recession	233 000	December	February	3.04	708 320
TOTAL	**2 076 992**				**3 852 706.2**

Source: Irrigated Agriculture Department, MOWRAM

The key constraint facing investment in agriculture is the poor state of the national economy: the ministry's budget is severely limited. Consequently, there are limited funds for technical survey and design, construction of irrigation infrastructure and operation and maintenance of existing irrigation schemes.

The main problems in provinces around the Great Lake and Mekong River in using high yield varieties of rice and other crop diversification and intensification include: (i) existing irrigation facilities have insufficient operation and maintenance funding (O&M), (ii) there are existing Farmer Water User Communities (FWUCs) but most farmers still do not understand the core concepts of O&M participation. While some know about community organization and development there is little action and low levels of application. Finally, (iii) such areas face annual floods and droughts.

Previously, there was no mechanism for charging farmers for water (except for pump stations in which case farmers bought fuel) so that the total cost of construction, operation and maintenance fell upon government. One dilemma facing MOWRAM was that without income from water charges it was unable to provide maintenance to keep existing systems operational and without good service, farmers were unlikely to be persuaded to pay even minimal water charges.

Farmers and local authorities often do not have the knowledge to improve and repair systems that are technically unsound. Many structures failed shortly after rehabilitation, e.g. the system did not perform as expected, and caused inundation problems. As a result, farmers are still confronted with water management problems and their energy and resources are unnecessary wasted. Moreover, there is no sound basis for sustainable management of the systems: it will be very difficult to incorporate many such existing schemes into further arrangements for water management and to develop confidence between the system managers and the system users, the farmers.

Landmines. In the aftermath of civil war some fertile agricultural land can still not be cultivated due to the presence of mine fields. Although about 3 200 km^2 are reportedly mined (the total number of mines estimated at about 5 million) most mine fields are not found on riceland. Even so over one hundred persons are reported killed or injured by landmines each month. The main areas affected are Kampot and Kompong Speu provinces in the south and Battambang, Banteay Meachey and Siem Reap provinces in the north, as well as the entire border with Thailand. Mines have frequently been laid along roads and watercourses to deny access to water. Few minefields are reported east of the Mekong River.

Cambodia ranks 140th of 174 countries and is among the bottom 20 percent worldwide. It is 22nd poorest in term of US dollar per capita income. On this basis 43 percent of the rural population were living below the poverty line in 1994 – nearly 3.7 million people and 85 percent of all those classified as poor. There is a non-economic dimension to rural poverty. Government policy is clearly focused on reducing poverty by improving income and food security. To achieve this, national and donor investment in the FWUC formulation process is extremely essential for operation and maintenance the existing working irrigation and drainage systems including flood control because these are toward the target of real Agricultural Productivity Development and commercialization of the surplus.

AVAILABLE WATER RESOURCES

Some 86 percent of Cambodia lies with the catchments of the Mekong River. Rising in China, the river passes through or borders Myanmar, Laos, Thailand and Viet Nam before discharging in the South China Sea. With a drainage area of 810 000 km^2 and a total length of 4 425 km, the Mekong is one of the major rivers of the world. The mean annual discharge entering Cambodia exceeds 300 billion m^3, and it is estimated that, with the contributions of downstream tributaries, some 500 000 m^3 is discharged annually to the sea (Table 5).

An important feature of the Mekong system in Cambodia is the Tonle Sap. During the wet season, as the water level in the Mekong rises, the flow in the Tonle Sap river draining the lake to the Mekong reverse and the lake fills, reducing the discharge downstream of Phnom Penh. By September/October, the level of the lake may have risen by 3 to 4 m and the area extended to 10 500 km^2. As the level of the Mekong falls, the water starts draining back, enhancing downstream dry seasonal flows, and the lake eventually shrinks to about 2 600 km^2 and less than 2 m depth in the dry season. The annual rise in the Mekong causes extensive flooding downstream of Phnom Penh.

Groundwater

There has to date been no comprehensive investigation of Cambodia's groundwater resources, but there have been two preliminary studies, both by the US Geological Survey. The first was a reconnaissance of the lowlands to determine, among other things, the availability of groundwater for dry season irrigation. The second was a general description and evaluation of groundwater availability based on test drilling data and well records obtained in the course of a USAID rural water-well development programme at various times between 1960 and 1993. The programme drilled 1 100 wells, 72 percent of which were productive. Depths ranged from 2 to 209 m with an average of 23 m. Information is also available from well drilling programmes done since the 1980s by NGOs and others, in particular OXFAM and UNICEF. The latter drilled more than 5 000 wells countrywide at depths of 20 m to 50 m. Recently, JICA completed a detailed groundwater survey in Takeo, Kandal, Svay Rieng, Prey Veng and Kampong Speu provinces.

Except for occasional thin sandy beds and lenses, the alluvium is of low permeability, and water yields are very low, typically 0.2 litre/sec. Yields from sandy layers are higher, typically of the order of 1litre/sec. Wells yielding more than 3 litre/sec. are rare. Of almost 7 600 wells for which UNICEF have records, less than 3 percent have yields more than 10 m3/hr. To date no groundwater sources of sufficient potential for large-scale irrigation have been identified. Any use of groundwater for irrigation is thus likely to be restricted to small-scale vegetable and fruit gardens, especially those cropped in the dry season. In Cambodia, wells are categorized as hand tubewells, shallow tubewells, deep tubewells and treadle pump wells.

TABLE 5
Hydrological characteristics of Mekong River tributaries

Tributary	Catchment (km^2)	Annual (million m^3)	Discharge (m^3/s)	Annual Runoff (mm)	Natural Low Flow (m^3/s)
Se Kong	28 500	32 200	1 368	1 310	40
Se San	17 100	17 300	547	1 010	28
Sre Pok	29 450	29 800	942	1 010	118
Prek Preah	1 510	760	24	505	3
Prek Krieng	2 450	1 240	29	505	5
Prek Kanpi	1 150	580	18	505	2
Prek Te	4 170	2 530	80	610	10
Preg chhlong	5 750	2 910	92	505	3
Stung Chinit	4 130	1 360	43	330	3
Stung Sen	14 000	6 190	196	440	8
Stung Staung	1 900	840	27	440	1
Stung Chickreng	1 030	450	14	440	1
Stung Streng	3 210	1 140	36	355	1
Stung Sisophon	4 310	1 900	60	440	2
St Mongol Borey	2 700	1 980	63	730	3
Stung Battambang	2 135	1 960	62	920	3
Stung Pursat	4 480	1 660	52	370	1
Prek Thnot	5 050	1 560	49	310	1
Mekong at Kratie	646 000	441 600	13 974	680	1 750

Source: Mekong River Commission, 1994.

Climate

Cambodia has a tropical monsoon climate with two seasons: the wet season, from May to October, resulting from the southwest monsoon and a dry season from November to April resulting from the

northwest monsoon. Usually the wet season is disrupted by a short dry spell during two weeks in July or August.

The annual average rainfall is 1 200-1 500 mm and the annual average air temperature 21-35^{0}C. The relative humidity ranges from 65-70 percent in January and February to some 85-90 percent in August and September. The annual evaporation is 2 000-2 200 mm, being highest in March or April at 200-240 mm/month, and the lowest in September or October at 120-150 mm/month. The monthly average evapo-transpiration is 90 mm during the wet season to 120 mm for the dry season.

PRESENT STATUS OF WATER AND LAND DEVELOPMENT IN CAMBODIA

Modern irrigation systems were first developed over the period 1930 to 1953 during the French colonial period. These included the Bavel project in Battambang (30 000 ha supplementary irrigation), a number of bunded storage reservoirs, including Kompong Sne in Prey Veng (100 million m^3), and Bat Roker and Lom Chang in Takeo (30 million and 6 million m^3 respectively), and several colmatage (flood recession) canals.

Following independence, between 1953 and 1960, 11 major land and water development schemes were undertaken with the assistance of the United States, including partial rehabilitation of Bavel, damaged during World War II, and of a number of other schemes built during the French colonial period. New projects included 13 000 ha of irrigation based on the largest of the Angkor reservoirs, Barai Occidental, and more than 50 colmatage canals in Kandal and Kompong Cham, bringing the area served to some 17 000 ha. With completion of these projects, the area under formal irrigation amounted to 74 000 ha. The first stage (5 000 ha) of the multipurpose Prek Thnot project in Kompong Speu was started in the late 1960s. The project included construction of a dam to provide ultimately year-round irrigation of 70 000 ha, but was left unfinished due to the start of the war. Events during the 1975-1979 period have had a major impact on agricultural systems throughout Cambodia. Recognizing the importance of irrigation, Government organized the construction of diversion works, bunded reservoirs and other structures, supplying a rectangular grid of canals across a large part of the rainfed area. In many cases, however, the works were designed and built with little regard to basic hydrological and engineering principles. In many instances, traditional water distribution and drainage patterns were disrupted, performance was below expectations and structures were damaged or destroyed by floods.

An inventory of irrigation systems carried out in 1993-1994 by the Mekong Secretariat listed some 920 schemes totalling 310 000 ha in the country. In rainfed lowland systems, the distinction between irrigated and rainfed area is not, however, well defined; although not supplied through a formal distribution system, much of the rainfed crop receives water additional to direct precipitation. Irrigation of crops other than rice is largely confined to gardens.

In the wet season, supplementary irrigation may be through direct run-of-river diversion, pumping or by means of release of stored surplus runoff. In the dry season, when in the majority of rivers there is little flow, irrigation is only possible from storage, or by lifting water, either by pumping or by traditional methods, from residual flows, floodwater or on a small scale, from groundwater. Pumping from the dry season flows from canals and streams connected to the Mekong or Bassac river is becoming a popular and productive dry season farming systems in Takeo and Prey Veng provinces.

Development opportunities

Gravity irrigation. The development options for irrigation offering the greatest scope for extensive development in Cambodia are exploitation of the abundant wet season river and stream flows to provide supplementary irrigation for the wet season rice crop, and provision of storage facilities to allow carryover for wet season runoff or flood water for irrigation in the dry season. At the other extreme, the areas which can be supplied from the smaller streams, may be only a few hectares. In the dry season, flows, where they occur, are sufficient to irrigate only a minimal area. Gravity diversion has low operating costs and reduced reliance on mechanical equipment which, unless properly maintained, is prone to breakdown. Where channels are incised, however, diversion structures may be needed to gain command. There is also a need to safely pass flood flows, which can be very much larger than the flows which can be usefully diverted.

TABLE 6
Principal rice soils of Cambodia

Group	Soil Type	Area (ha)
Young Alluvial Soils	*Alluvials* Lacustrine Alluvials Brown Alluvial	1 706 400 1,037,300 276,000
Leached Acid Soils on Old Alluvium	Alluvials	included above
Poorly Drained Lowland Soils	Cultural Hydromorphics Grey Hydromorphics	1 289 600 1 725 200
Imperfectly Drained Lowland Soils	Brown Hydromorphics	670 100
Acid Sulphate Soils	Alluvials	278 000

Source: Irrigated Agriculture Department, MOWRAM

Pump stations. Pumped abstraction is appropriate where provision of the work necessary for gravity diversion would not be practical, or in terms of the quantity diverted, excessively costly. However, experience in Cambodia with fixed pump schemes has been disappointing, for a number of reasons, including: inadequate water source or siltation; over-dimensioning or over-sophistication of the pump; use of fuel inefficient Soviet-designed pump; technically unsound irrigation schemes; and lack of maintenance. Pump schemes are vulnerable to poor maintenance. While capital costs of pump abstraction tend to be less than for gravity diversion, annual operation and maintenance costs are significantly higher: some US$80/ha/year for pump schemes as against US$20-25/ha/year for gravity irrigation schemes in Cambodia.

Mobile pumps. Averaging 3 hp, mobile pumps are used during the wet season to supply supplementary irrigation water from a convenient source to small areas of adjacent land that is out of command. In the dry season, they provide water for irrigation of the recession crop, where they replace traditional pedal pumps and scoops. They are used to a lesser extent to provide water from residual river flows and water stored in canals for irrigation of a second crop on terrace lands, and for irrigating vegetable and fruit gardens.

Shallow bunded reservoirs. Storage for wet season supplementary and dry season irrigation is provided by bunded reservoirs storing water at a depth of 1 to 3 metres. There are 2 800 such reservoirs countrywide. The water stored may derive either from upstream runoff or from

impoundment of floodwater from rivers. In the wet season, reservoirs commanding terrace lands, as well as providing storage, serve also as diversion structures. The area supplied is reported as 200 000 ha in the wet season, and 65 000 ha in the dry season. Dry season irrigated areas generally range from very small to several thousand hectares, with the large areas being flood recession areas.

Colmatage canals. 'Colmatage' or warping canals are cut to bring silt-laden floodwater to low-lying land behind the levees of the Mekong and Bassac rivers. Set at a relatively high level, these canals are closed off from the river by a temporary bund until mid-August to allow harvest of the previous season's crop. The canals are then filled on the rising flood and then, when the flood falls, water is retained at the level of the canal inverted, allowing recession cropping. In some cases, a head gate is provided, allowing water retained at a higher level. On the lower land, recession crops are grown. The canals also serve an important fishery function permitting passage of brood-stock on to the floodplain.

Polders. The flood recession areas offer some of the most fertile soils. Polders to exclude floods could permit cultivation in the wet season. High external water levels, however, while facilitating supplementary irrigation, would necessitate pump drainage. In addition, excluding flooded land in the polder would deny it the silt upon which its fertility depends. It should be noted that most farmers also own terrace land on which they are already fully employed during the wet season.

Strategies for development of water resources

The use of water resources in general: to prevent conflicts among water uses for different purposes and in different areas, and create an environment conducive to the satisfaction of present and foreseeable demands consistent with environment protection. These include: planning water resources use and development in priority areas; licensing water uses; controlling groundwater abstraction and use; and cooperation with other parties to the 1995 Mekong Agreement to implement its provisions.

Development process

Irrigation and drainage: to expand irrigated area from 16.62 percent to 20 percent by the year 2003 given the high irrigation potential (1 667 300 ha or even more in the future), to enhance food security, provide job opportunities and increase the incomes of the rural population; and through irrigation improvement, to mitigate the effects of floods and other emergencies. Specifically called for are: rehabilitation of existing irrigation schemes; development of cost-effective, short-gestation, appropriate and private irrigation technologies; development of small-scale gravity irrigation systems; and the improvement and expansion of areas covered by medium and large irrigation systems as the institutional capacity for planning, construction and O&M of such systems is enhanced.

Water supply, sewerage and sanitation: to provide sufficient and safe water supplies to urban and rural areas, to protect the health of the urban and rural population, including: improvement of access to urban water supplies; expanding water service in rural areas; setting drinking water quality standards; drinking water quality monitoring; improvement of urban drainage and sewerage; expanding sanitation services, especially in rural areas and organizing health education programmes.

Hydropower development: to exploit the country's potential to improve the standards of lining of the population and reduce the present cost of energy, consistent which environment protection requirement, including: review of data and information on hydropower development; investigation of Cambodia's potential for hydropower development and setting priorities; assess project feasibility for multiple uses; planning hydropower development within the framework of overall water resources plans; assess the impact of each hydropower development project on the watershed concerned; financial sustainability of hydraulic infrastructure; introduction water use fee concept to cover the costs of service delivery and O&M; enhancing community participation in the design, construction,

operation and management of hydraulic infrastructure; introducing user participation in managing rehabilitated and newly constructed irrigation schemes; and promotion of private sector involvement in the construction of hydraulic infrastructure.

Water resource protection: to improve water quality for present and future demands and ensure that water bodies have the capacity to sustain aquatic and fish life; to protect human and animal health to prevent water pollution from point sources; prevent water pollution from non point sources; and prevent groundwater pollution.

Control and abatement/reduction of flood effects and other hazards: to prevent damage resulting from floods, drought, watershed degradation, erosion and sedimentation; and to protect aquatic and fish resources, including: control of floods and abate/reduce their effects; improve weather forecasting to ensure timely warning regarding natural occurrences such as typhoons, floods and drought; preventing watershed degradation, erosion and sedimentation; protection of fish stocks; and cooperation and exchanging information with other Mekong Basin countries to prevent the harmful effects of floods, watershed degradation, erosion, sedimentation and drought that might originate in activities carried out in these countries

Policy, legal and institutional strategies: to create an 'enabling environment' for integrated water resources management and development, by means of: formulation and adoption of a coherent policy for the water sector as a whole; formulation of a comprehensive legal framework for water sector institutional coordination; strengthening the MOWRAM data base and information system to facilitate the integrated management of water quantity and quality and determining balance between availability and demand; strengthening the capacity of ministry staff at central and decentralized levels; disseminating information on water resources in public meetings, by radio broadcasts and publications such as leaflets and posters.

Planning framework

Development activities in Cambodia are planned within the framework of Five-Year Socio-Economic Development Plans (SEDP), which are prepared by the Ministry of Planning on the basis of sectoral contributions from line ministries. SEDPs set out RGC policy and strategy and detail sectoral investment levels. The First SEDP ran from 1996 to 2000 and the Second SEDP, which is in final draft form, will run from 2001 to 2005.

An annual meeting takes places each year between RGC and development partners at which progress in the preceding year is reviewed, plans for the future discussed and funding commitments reaffirmed. The Council for the Development of Cambodia (CDC), under the Prime Minister's Office, organizes this meeting. Before each annual meeting, CDC prepares the government's statement under the title Socio-Economic Development Requirements and Proposals (SEDRP), including programme and project details and their funding requirements for the next three years.

Actual programme and project interventions are listed in a three-year rolling Public Investigation Programme (PIP). Each June/July, projects for inclusion in the PIP are discussed in the Ministry of Planning. Executive agencies prepare their annual work plans and corresponding budget requests on the basis of programme and project included in the SEDP and PIP, physical progress in previous year, new projects identified and the availability of funds is determined.

The ministry divides Cambodia into three planning zones, an Upper Area, and Central Floodplain and Coastal areas in part to facilitate an equitable distribution of development funds. It issued a Short, Medium and Long Term Strategic Plan in April 1999 including 63 projects (of which eight were ongoing), at a total cost of US$486 million. MOWRAM prepared a five-year rehabilitation and development plan (RDP) on water resources and meteorology for the Second Five-Year Plan

(2001-2005). The plan is an ambitious programme with a comprehensive list of 874 projects costing Riels 2 062 billion (US$528 million) over five years. Annual budget for investing on the development of the water resources is illustrated in Table 7.

The PIP 2001-2003 lists 32 ongoing, committed and high priority projects under MOWRAM with a total value of $113 million, together with two 2000 flood-related rehabilitation project funded by ADB and World Bank valued at some $20 million.

TABLE 7
MOWRAM Short and Medium Term Investment Plan

Projects	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Completed / Ongoing	3.90	4.10	17.20	16.10	17.30	6.80	6.70	5.40	0.40			
Pipeline			0.50	7.30	16.20	28.60	35.10	23.00	21.00	21.00	21.00	9.00
Medium Term						9.70	29.30	25.40	31.10	25.00	27.00	15.00
TOTAL	3.90	4.10	17.70	23.40	33.50	45.10	71.10	53.80	52.50	26.00	48.00	24.00
Expenditure by Plan Period	**$7.5 million (1996-2000)**				**$190.8 million (2001-2005)**				**$200.3 (2006-2010)**			

Source: MOWRAM, 2001

NATIONAL INSTITUTIONS IN THE WATER SECTOR

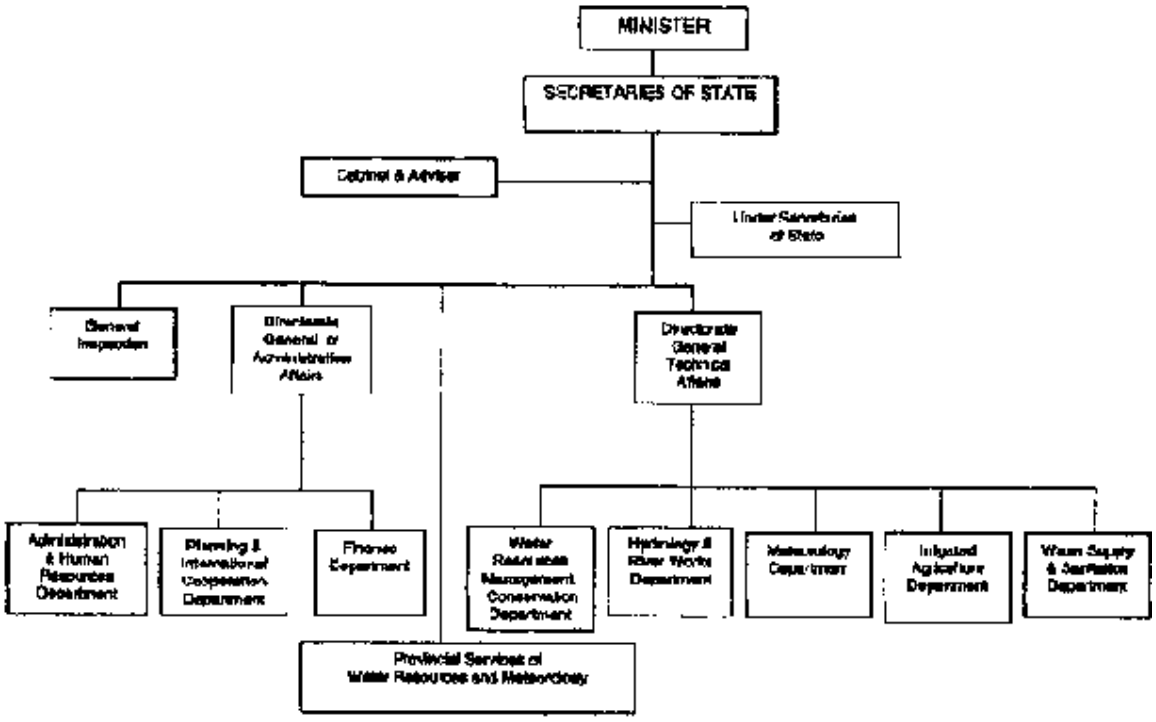
In Cambodia, irrigation is the responsibility of the Ministry of Water Resources and Meteorology (MOWRAM), established in 1998 and which previously was part of the Ministry of Agriculture, Forestry and Fisheries. Its main functions are: (i) formulation of water policies; (ii) study and research; (iii) technical investigation for multipurpose dams, irrigation, drainage, water supply and river works; and (iv) planning, design and rehabilitation of existing projects and their operation and maintenance.

MOWRAM is headed by a minister assisted by secretaries and under secretaries of state. There are two divisions, administration and technical, headed by a director general and a Provincial Water Resources Department. The Technical Division has six subdivisions or departments: water resources management, hydrology and river works, irrigated agriculture, engineering and design, water supply and meteorology (Figure 2). The poor state of the national economy means the ministry's budget is severely limited. As a consequence, there is a lack of funding for technical surveys and design, construction of irrigation infrastructure and operation and maintenance of existing irrigation schemes.

For successful implementation of the irrigation development activities and for the sustainable operation and management of irrigation systems, the Government has entrusted the Ministry of Water Resources and Meteorology to review and evaluate all irrigation systems having the potential to effectively serve the development of national economy, standardize the statutes of the Farmer Water Users' Community (FWUC) to help facilitate and organize the farmers, to carry out feasibility studies and construct irrigation systems including diversions, intakes, outlets and canal systems to supply irrigation water to farmers' fields in an efficient and sustainable manner and to cooperate with the concerned ministries to create the FWUCs.

FIGURE 2

Organization structure, Ministry of Water Resources and Meteorology (MOWRAM)



DONOR ASSISTANCE IN THE WATER DEVELOPMENT SECTOR

Donor assistance in development of the irrigation sector in Cambodia has been substantial. Many bilateral and multilateral institutions are involved in irrigation. The Mekong Secretariat (now the Mekong River Commission), prepared an inventory of potential hydropower and irrigation projects and was also responsible for the emergency rehabilitation of key irrigation structures damaged by floods in 1991 and initiated a longer-term countrywide irrigation rehabilitation study. The Asian Development Bank provided funds for Special Rehabilitation Assistance Projects that included irrigation. It plans to finance the Stung Chinit Water Resources Development Project, a large-scale irrigation scheme in Kampong Thom. To generate employment, ILO has instituted a labour-intensive infrastructure rehabilitation programme. In the irrigation sector, rehabilitation of canals and minor structures is being undertaken on the Bavel (Battambang) and Barai (Siem Reap) schemes. Funds are being provided by UNHCR, UNDP/CARERE, WFP and the Netherlands.

Japan's International Cooperation Agency (JICA) is providing US$10 million for floodplain area development and colmatage rehabilitation. The World Bank is extending a technical assistance grant of US$2 million to increase the capacity of MOWRAM staff. The Food and Agriculture Organization (FAO) funded a pilot project on water control technologies. The European Union as part of the Programme de Rehabilitation au Secteur Agricole du Cambodge (PRASAC) is developing local capacities and building farmers association in the provinces close to Phnom Penh. The GTZ has been providing support for investigation and study of small-and medium-scale irrigation schemes in Kampot and Kampong Thom.

The World Bank-assisted Agricultural Productivity Improvement Project (APIP) hydrology component focuses on capacity-building within MOWRAM nationally and at provincial level in Kampong Thom and Kratie provinces. APIP will provide training, technical assistance, vehicles equipment and staff allowances to develop and support the PSWRAM in Kampong Thom.

Non-governmental organizations

NGOs have been providing assistance to the agricultural sector since the early 1980s. Currently, 20 are involved with irrigation, providing materials and equipment and/or technical assistance, challenged directly to central, provincial or district authorities. Work has focused on rehabilitation of existing irrigation systems including repair of reservoir bunds and outlets works, provision and repair of pumps, and rehabilitation of canal networks and minor control structures. Selection of schemes has not been in conformity with a national plan. Schemes have been treated as isolated entries, often neglecting complex hydrological features and performance of the facilities created has often been unsatisfactory. NGOs have been involved since 1991 in organizing and promoting farmers' organizations, in particular water users groups, with a view to encouraging farmers' participation and involvement in planning and operation and maintenance of irrigation systems. All NGOs working in Cambodia are listed in Table 8.

The water sector potentially can contribute to many of the social, and the government has recognized, in the April 2000 Social-economic developments and proposals, "a need to develop a well-defined strategy". In irrigated agriculture, elements of the current strategy include rehabilitating existing schemes, promoting the ability of communities to maintains and operate their own facilities, and investing (in the longer term) in multi-purpose reservoirs. The water sector will contribute in other ways to social goals, such as the provision of supplies of water for electricity and irrigation, but time will be required to develop appropriate goals.

TABLE 8
Organizations active in Cambodia's irrigation sector (April 2000)

Organization	Location	Since	Status	Activities
ADRA	Siem Reap	1970s	On-going	Agricultural extension in medium-scale irrigation system (Barai system)
CWS	Kandal, Kampong Thom	1979	Phase out	Investigation of small-scale irrigation and drainage, community development
MWR	Various	1979	On-going	Ministry responsible for irrigation and water resource development in Cambodia
ACR	Takeo	1980	Finished	Pump irrigation systems, organization of water user groups ag. extension, support to PLAC
CAA	Takeo, Banteay Meanchey	1980 1992	On-going Completed	Small-scale irrigation and drainage, community organization of water user groups
ITC	Phnom Penh	1981	On-going	Technical University producing rural engineers
PLAC	Phnom Penh	1981	On-going	Agricultural College teaching water resource technicians, meteorology
AFSC	Kampong Chhnang Pursat	1985 1989	Phase-out	Small-to medium-scale irrigation and drainage structures
SAWA Cambodia	Pursat, Siem Reap, Phnom Penh	1985	On-going	Irrigation and drainage consultants, small-and medium-scale systems, criteria for Social Fund
MCC	Prey Veng	1986	On-going	Rehabilitation of network in medium-scale irrigation system (Kampong Sne), community organization of water user groups
CIDSE	Svay Rieng Kampot	1988 1992	On-going	Small-to medium-scale irrigation and drainage, integrated rural development, agricultural extension
CNMC	Phnom Penh	1991	On-going	Policy and coordination, information development, international agreements
FAO	Kampot, Battambang, Siem Reap, Takeo, Kampong Thom, Kampong Cham	1991	Completed	Special Programme for Food Security (Mlech, Bavel, Barai, Tuk Char, Thot Te Systems and others)
JICA	Floodplains, Kandal, Takeo, Phnom Penh	1991	On-going	Floodplain irrigation development projects (colmatage), study of Kandal Stung system, technical assistance to MWR, hydrologic

				gauging, capacity building at MWR (planned)
LWS	Phnom Penh	1991	Completed	Rehabilitation of meteorological network, technical assistance to MWR, Civil Aviation
ANS	Battambang, Stung Chinit, Kampong Saom, Kampong Thom	1992	On-going	Small-scale irrigation and drainage structures, integrate rural development, community organization (Prey Nop and Stung Chinit Projects)
CARERE	Pursat, Battambang, Banteay Meanchey, Ratanakiri, Siem Riep	1992	On-going	Small-to medium-scale irrigation and drainage, ag. Extension, rural development, institution building, community development
CCDP/HOPE	Pursat	1992	On-going	Small-scale irrigation and drainage, community organization, hydrologic data collection
COR	Prey Veng	1992	On-going	Promotion of treadle pumps
Concern Worldwide	Banteay Meanchey, Pursat, Siem Reap	1992	Phase Out	Small-scale irrigation and drainage
ILO	Siem Reap, Battambang	1992	Completed	Labour-based medium-scale irrigation and drainage (Barai & Bovel systems), community organization
New Humanity	Kampong Speu	1992	On-going	Small-and medium-scale irrigation and drainage, ag. extension, community development
VSA	Takeo	1992	Completed	Integrated Rural Development
WFP	Numerous	1992	On-going	Food-for-Work repairs to small-and medium-scale irrigation and drainage systems
BFD	Battambang	1993	On-going	Small-scale irrigation and drainage structures, community development, agronomy support
ISF	Kampong Charm	1993	Completed	Small-scale irrigation and drainage development, community organization of water user groups
MRD	Kampot, Kampong Speu	1993	On-going	Promotion of groundwater irrigation, small-scale irrigation and drainage development
ADB	Takeo, Prey Veng, Kampong Cham, Kampong Thom, Phnom Penh	1994	On-going	Special rehabilitation assistance loan for medium-scale irrigation development (Tuk Char, Kampong Sne, Thnot Te, O thom-completed), Stung Chinit Water Resources Development Project (on-going), capacity building in MWR (from 8-2000), Planning Community Irrigation Rehabilitation Project
GTZ	Kampot, Kampong Thom	1994	On-going	Investigation and study of small-to medium-scale irrigation systems (Stung Pe), community development and agricultural extension support
IDE	Prey Veng, Svay Rieng, Takeo, Kandal, Kampot	1994	On-going	Promotion of treadle pump and appropriate technology for irrigation development
CIAP-IRRI	Takeo, Kandal, many other pilot locations	1995	On-going	Groundwater irrigation pilot projects, soil and water management, agronomy research
CAAEP	Takeo, Kandal, Siem Reap, Kampong Thom, Kampong Cham, Battambang, Pursat, Bantheay Meanchey	1995	On-going	Agricultural extension
EC/PRASAC	Kampong Cham, Kampong chhnang, Kampong Speu, Takeo, Prey Veng, Svay Rieng	1995	On-going	Medium-scale irrigation and drainage development, community organization, agricultural extension, credit
Japanese Embassy	Various	1995	On-going	Budgetary support for MWR rehabilitation of small structures in several provices
AFD	Kampong Saom, Siem Riep, Kampong Thom	1996	On-going	Medium-scale irrigation development (Prey Nop, Makak and Stung Chinit Systems)
ECTA	Kampong Cham, Kampong chhnang, Kampong Speu, Takeo, Prey Veng, Svay Rieng	1996	Completed	Technical assistance for food-for-work irrigation and drainage projects in the 6 PRASAC provinces
Social Fund	Phnom Penh	1996	On-going	Funding small-and medium-scale irrigation-and medium-scale irrigation and drainage systems
World Bank	Phnom Penh,	1996	On-going	Agriculture Productivity Improvement Project for

	Kampong Thom, Kratie			small-and medium-scale irrigation and drainage development, training data. Northeast Rural Development Project for community development (MRD)

Law on water resources management

Cambodia's Law on Water Resources Management details a number of key policies for the water sector, such as:

- All natural resources including water and land are owned by the State and are managed by the Government in accordance with the provisions of this Law and the Regulations made thereunder (Article 3);

- Water resources plans shall be formulated by basin, sub-basin or aquifer, and shall be coordinated by a national plan. Water resources plans shall be aimed at balancing water availability with present and foreseeable demands, including measures for the protection of water against pollution (Article 7);

- Everyone has the right to use water resources freely for drinking, washing, bathing and other domestic purpose, the watering of domestic animals and buffaloes, fishing and the irrigation of gardens and orchards in an amount not exceeding that necessary to satisfy the individual and family need of the user (Article 8);

- The use of water is subjected to the payment of water use fees... (Article 17);

- The discharge, disposal or deposit of polluting substances...shall be subject to a wastewater discharge license... (Article 21); and

- Without prejudice to the principle of Cambodian sovereignty, Cambodia has the right to use, develop and manage international river basins on her territory within her reasonable and equitable share, consistent with national environment and development policies and with the obligations stemming from the international agreement to which Cambodia is party (Article 40).

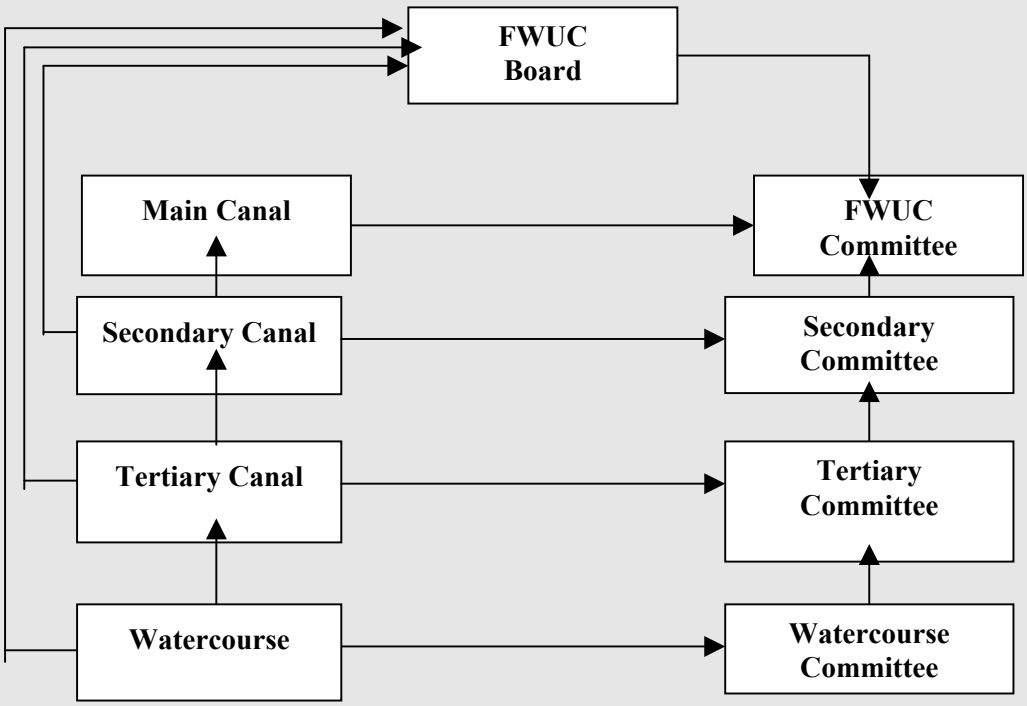
Article 8 provides for "free water uses" for basic household needs, while other articles provide for licensing all other uses. After the fall of the Khmer Rouge regime in 1979, local authorities began allocating land and houses on a wide scale, with a maximum holding of 5 ha. Private ownership of land-use rights (not land itself) was legally reintroduced in Cambodia in 1989, when it was declared that all Cambodians could own, use and inherit land-use rights granted by the government. The State of Cambodia Land Law (1992) allows citizens to acquire land-use ownership rights over land they have peacefully occupied for five years. However, the process of land titling has been cumbersome, so that less than 15 percent of applicants have received certificates of ownership (implying, strictly, that the remainder are illegal occupants, which provides them with no protection in the face of widespread land-grabbing by more powerful people). The poorest half of the population shares less than one quarter of the cultivable land, one family in six is landless, and there is extensive land speculation and aggregation by the wealth.

Disparities in access to agricultural land appear to be growing, due to population growth and fragmentation, forced sales to pay debt, usurpation of land by the more powerful and deficiencies in land law enforcement. It is estimated that 15 percent of total land area changed hands from 1993 to 1998, with the poor as net sellers and the wealthier as net buyers. Land disputes contribute the second highest number of legal cases in Cambodia. There have been further land reforms since 1998, but disputes are still occurring as a result of insecure tenure and illegal transactions and usurpation.

Further reform and improvements in administration are anticipated in the government's Socio-Economic Development Requirements and Proposals (Ref. 30) and the Immovable Properly Bill, which would reform the Land Law, is agreed by the National Parliament and Senate, and is approved and signed by the King of Cambodia.

The formulation of the manner in which the farmer water user community participates in irrigation management is very important. The Farmer Water Users Community (FWUC) is a mechanism established by farmers, and has the duty to manage water use in any irrigation system by obtaining due recognition from the Royal Government of Cambodia. The FWUC is leaded by the Farmer Water Users Community Committee under the Board of FWUC as the facilitators (Figure3).

FIGURE 3
Cambodia Farmer Water User Committee (FWUC) structure



Irrigation development, rehabilitation or extension programmes shall be implemented only on the basis of the feasibility and demand of the majority of the farmers. During the planning and implementation of irrigation projects full participation of organized users shall take place at all levels from the very beginning. Formation of FWUC shall therefore be the primary task leading towards the implementation of an irrigation project. Upon completion of the project, the responsibility of operation and maintenance and the emergency repair shall rest with FWUC gradually:

- in year one: government shares 80 percent and farmer members 20 percent;
- in year two: government shares 60 percent and farmer members 40 percent;
- in year three: government shares 40 percent and the farmer members 60 percent;
- in year four: government shares 20 percent and farmer members 80 percent; and

- in year five: the government shares 0percent and the farmer members 100 percent.

Irrigation service fee (ISF)

The actual irrigation service fee (ISF) is decided by FWUC following this formula:

$$Y = \frac{X_1 + X_2 + X_3 + X_4 + X_5}{Irrigation\ Service\ Area} + 20\%\ of\ the\ increased\ production\ in\ one\ hectare$$

Where, X is the O&M costs

X_1 = expenditure on maintenance and repair
X_2 = expenditure on fuel (for pumping)
X_3 = expenditure as the contribution to the Community Board
X_4 = expenditure on administration
X_5 = expenditure on contingency
Y = ISF per hectare

One-fifth of the increased production remains in an FWUC bank account as a fund for emergency repairs and maintenance expenditures or for irrigation system and farm water management improvements. For simplicity, in the current situation the increased production of wet season irrigated rice compared to rainfed rice is estimated at about 0.7t/ha. The FWUC will therefore collect annually 140kg/ha of rice as its share of 20 percent increase in production. This should be continued for the first five years following which, depending on the financial situation, the FWUC may reduce the percentage (but to not less than 5 percent of increased production). The above expenditures apply only for the irrigation schemes constructed by the government fund and/or the support from international and national agencies.

OBJECTIVES OF THE PARTICIPATORY WATER MANAGEMENT PROGRAMME

The government objective in creating the participatory irrigation management programme is: (1) to receive efficient, sustainable, reliable and environmentally friendly irrigation systems, (2) to promote irrigated agriculture ensuring food security and national economic growth, (3) to gradually increase the role and responsibility of organized farmer users in every stage of programme implementation thereby decreasing government responsibility for development of the irrigation sector, including repairs, operation and maintenance, (4) to enhance the capability of the farmers and the Farmer Water User Community in managing and safeguarding the irrigation systems, (5) to promote awareness of the farmers in taking over management responsibility of government managed irrigation schemes and expedite the transfer process to the FWUCs, (6) to encourage international financing agencies to increase funding in developing and managing irrigation systems with active involvement of the user farmers, and (7) to bring about uniformity in the selection and implementation process of irrigation development and management among the government institutions and supporting national and international agencies involved in irrigation extension.

ONGOING PROGRAMMES IN WATER RESOURCES DEVELOPMENT

MOWRAM is involved in the following types of programmes and projects: institution building; policy/strategy/legislation; single/multi-resources surveys; area-specific single/multi-purpose planning studies; feasibility studies; detailed design and preparation of tender documents; construction; and operation and maintenance

A new national programme as a demonstration pilot on participatory irrigation management – including the design of farmer water user communities (FWUC), initial operation and maintenance cost provision to the new FWUCs. The first phase of this programme is five years. The national programme will cover 11 sites at existing working irrigation systems in 11 provinces. MOWRAM is the executing agency of this programme under ADB financing. Major programme objectives include: establishing FWUCs in existing working irrigation systems in provinces around the Great Lake and along the Mekong and Bassac rivers; operating and maintaining existing irrigation systems for increased agricultural productivity, poverty reduction, and improving food and income security; establishing FWUC support teams; and strengthening MOWRAM capacity building in participatory irrigation management (PIM), irrigation management transfer (IMT), national FWUC policy, monitoring and evaluating the performance of irrigation systems and FWUCs; and implementing, improving and developing Circular No. 1 of the implementation policy for sustainable irrigation systems in provincial project FWUCs.

The Rehabilitation Colmatage Canals Project funded by the Japanese Government in Kiean Svay district. The objectives of the project are to establish a farmer water user community of the beneficiary farmers for sustainable irrigation management of the irrigation systems, increase agricultural production and improve life standard of farmers through rehabilitation of the colmatage irrigation facilities.

The medium scale irrigation system development project funded by France. The project is located in Prey Nup, Sihanoukville. Its objective is to protect flood protection dykes (polders) from sea water to increase agricultural production by forming farmer water user communities. The project also aims to implement existing national policy on sustainable management irrigation systems, decentralization of services delivery, and empowering the planning and developing process in the operation and maintenance the irrigation systems.

The PRASAC project is financed by the European Union (EU) to cover 15 medium scale irrigation schemes in six provinces. The project purpose is to improve the food and income security via rehabilitated the existing medium scale irrigation schemes and organize the farmer water user community to sustain the operation and maintenance the rehabilitated irrigation system. The formation of farmer water user communities process follows existing national policies.

The results of these programmes and projects have illustrated changes and improvement the quality of the irrigation water management from non-discipline, non-effectiveness, and non-efficiency to discipline, effectiveness, and efficiency. The farmers understand and are interested in participating themselves as members of FWUCs. Farmers agreed to pay a substantial water fee to afford the O&M costs. Yields rose from 1.8 t/ha to 2.5 t/ha for wet season crops and from 2 t/ha to 3.5 t/ha for dry season crops. Crops and fruits were of improved quality. MOWRAM established 25 FWUCs with 37 739 families for an irrigated area of 40 780 ha. These FWUCs were started using existing national policies, scenarios and standards. Other data regarding the new programmes are still being researched and assessed.

RECOMMENDATIONS AND CONCLUSIONS

Cambodia's investment in water resources and land in response to the special programme for food security (SPFS) is limited. There is a lesser impact of SPFS on agricultural productivity improvement than might be expected. FAO is not the donor, but it can share existing funding for SPFS with the Cambodian government for substantial benefit by using the participatory approach to inform, mobilize and organize farmer understanding of the importance of FWUCs and the responsibility and ownership for further O&M after construction and rehabilitation of the irrigation systems is complete. FWUCs

must be established *before* irrigation rehabilitation and construction. All stages of design or redesign and reshape for construction and rehabilitation of irrigation systems must have FWUC involvement. Let all members of FWUCs know and understand how important the contribution of affordable water fees for O&M the irrigation systems.

The FWUCs must receive training on all aspects of water management including crop water requirement, frequency of irrigation, water distribution, some idea of the importance of participatory irrigation management, irrigation management transfer, and national policy for FWUCs from the multi-disciplinary support team for FWUCs assisted by the external FWUC experts.

Irrigation system development (O&M) should respond to FRUW requests. FWUCs should be involved from the beginning in surveys, planning, implementation of O&M, supervision and also during test checking of the facilities constructed. The proposed irrigation alignments and layout should be agreed with the FWUCs: their opinions should receive consideration.

Assessments of water charges must reflect both the value of water – especially in the dry season – and the cost of supplying it to the field. Farmers who can afford to pay the O&M cost (the water fee calculation) must follow the guidelines of Mowram Circular No.1. The basic principle of any pricing procedure is to ensure that water charges cover all O&M costs. All this must be included in the next investment implementation in water resources and land for SPFS in Cambodia.

Annex A

Ongoing Projects

MOWRAM Ref.No	MinPlan Ref.No	Project/Intervention	Cost ($M)	Donor	2001	2002	2003	2004	2005
		CAPACITY BUILDING							
13	479	Improvement of survey and Forecast System on Meteorology and Agro-Meteorology	0.6	Japan					
14	395	Upgrading Technical Service Center for Irrigation System	6.8	Japan					
15	nn	Hydrology and Land & Water Resources Development for Agriculture	0.5	Japan					
27	new	Capacity Building in the Ministry of Water Resources and Meteorology	0.8	ADB-TA					
35	nn	Hydrology Improvement Network (for countries)	0.5	MRC					
		STUDIES							
nn	new	New Monitoring System for Land and Water Resources in Stung Battambang	1.0	Japan					
23	new	Study on Rehabilitation and Reconstruction of Agriculture Production System in Stung Slakou River Basin in Takeo Province	1.5	Japan					
33	new	Stung Chikreng Water Resources Development	0.4	France					
34	nn	Land Resources Inventory for Agricultural Development (Cambodia and Vietnam)	0.4	MRC					
36	nn	Comprehensive Study of Chaktomuk Area Environment Hydraulic and Morphology	0.3	MRC					
		CONSTRUCTION ETC.							
10	309	Colmatage Canals Improvement Project	9.5	Japan					
31	146	Prey Nup Polder Rehabilitation Project (Extended)	8.6	AFD					
32	nn	Project S Appui au Development Agricole Periurbain Autour du Phnom Penh Bassac	2.1	AFD					
nn	nn	Agriculture Programme Loan	9.5	ADB					
37	nn	Baray Irrigation Management	0.5	ILO					
38	397	Kamping Poy Irrigation Rehabilitation Project	0.4	APS					
39	nn	Other Integrated Development	2.8	APS					
48	new	Agriculture Pructivity Improvement Program	5.3	WB					
59	289	Stung Chinit Irrigation and Rural Infrastructure Project	23.5	ADB					
nn	564	Emergency Flood Rehabilitation Project	12.4	ADB					
nn	new	Flood Emergency Rehabilitation Project	10	WB					
nn	nn	Tropaing Veng Irrigation Rehabilitation	0.05	Japan					
nn	nn	Svay Khom Irrigation Rehabilitation	0.09	Japan					
nn	nn	Kamping Poy Irrigation Rehabilitation Project	0.18	Japan					

Annex B

Medium Term Propects

MOWRAM Ref.No	MinPlan Ref. No	Project/Intervention	Cost ($M)	Donors	2001	2002	2003	2004	2005
		CAPACITY BUILDING							
A	nn	Capacity Building II under Northwest Cambodia Irrigation Sector Project	0.3	ADB					
B	nn	National Capacity Development under DANIDA Environment Programme	1.0	Denmark					
D	nn	Formation of FWUCs, Operation and Maintenace	1.0	ADB					
G	nn	Capacity Building III	1.0	ADB					
24	398	Improvement of Meteorological Services in connection with Disasters and Development of Socio-Economy	7.2	Japan					
K	nn	Strengthening of MOWRAM Department of Meteorology and Hydrology and River Work	1.5	bilateral					
L	nn	Strengthening of MOWRAM Department of Water Resources Management and Conservation	1.0	bilateral					
		STUDIES							
C	nn	Northwest Cambodia Irrigation Sector Project	0.9	ADB					
E	nn	Irrigation Management Strategy	0.5	France					
17	nn	Battambang Agricultural and Rural Development Project	2.0	Japan					
18	nn	Prek Thnot River Basin Multipurpose Development Study (Feasibility Study)	2.0	Japan					
H	nn	Groundwater Investigations	1.0	bilateral					
IA	nn	Rehabilitation IA	1.0	WB					
J	nn	Small Scale Project	1.5	Japan					
		CONSTRUCTION ETC.							
20	393	Rehabilitation of the Kandal Stung Irrigation System in the Lower Prek Thnot Basin	6.7	Japan					
21	new	Urgent Rehabilitation Project of Reservoirs for Agriculture	4.9	Japan					
22	new	Urgent Rehabilitation Project of Baray Reservoir Project	10.0	Japan					
F	nn	Northwest Cambodia Irrigation Sector Project	20.0	ADB					
61	396	Rural Community Irrigation System Rehabilitation Project	58.2	Japan					
IB	nn	Rehabilitation IB	60.0	WB					
64	nn	Community Based Rural Development Project	4.1	IFAD					

Report on China's development and investment in land and water

INTRODUCTION

China is known as a natural resources deficient country. Quantitatively speaking, water resource per capita is approximately 2 200 m^3, only 30 percent of the world average. Arable land per capita is 0.1 ha, only 40 percent of the world average. Qualitatively speaking, China's water and land resources are far from being easily developed and utilized due to the fact of slope land, soil layers, erosion and other problems. Geographically, south China has abundant water but is deficient in land while north China is abundant in land but deficient in water. The combination of a large population and insufficient natural resources severely impedes the sustainability of China's agriculture and social economic development.

In order to increase capital construction in agriculture, enhance the ability to prevent and control disasters, strengthen the foundation of agriculture, facilitate the steady improvement of comprehensive agricultural production capacity and ensure the sustainability of agriculture, the Chinese government has made significant efforts in water and land development and conservation, which can be reflected in the following aspects:

- comprehensive agricultural development (CAD);
- farmland irrigation and water conservancy construction;
- construction of commodity bases for grain, cotton, oil products and sugar products;
- land resources management;
- fertilizer and other agricultural inputs;
- ecological construction in agriculture and improvement of the agro-eco system.

Thanks to these unremitting efforts, notable results have been achieved in China's water and land development. This is demonstrated by the fact that China feeds 22 percent of the world's population with only 10 percent of the world's arable land. And with per capita availability of grain having risen to some 400 kg, 1.3 billion Chinese people now live comfortable lives.

As water and land management in China involves different administrative departments, and the manner of investment in water and land by the state, collective units and farmers varies, it is difficult to get accurate statistics on total investment in water and land nationwide. Therefore, we try to provide information and understanding concerning water and land development and conservation by introducing several major activities and programmes.

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Department of Development and Planning
Ministry of Agriculture, China

Achievement in China's water and land development

All-round and rapid development in agricultural production

Since China's founding, agricultural production recovered rapidly and developed continuously. Production capacity has risen greatly. In 1978, total output of grain and cotton reached 304.47 million tonnes and 2.167 million tonnes respectively, increasing by 1.69 and 3.88 times over 1949. During the same period, livestock inventory was 93.89 million head, an increase of 56.4 percent. Total meat output including pork, beef and mutton was 8.563 million tonnes, 2.89 times more than 1949. Fisheries output was 4.653 million tonnes, an increase of 9.4 times against 1949.

TABLE 1
Production of major commodities 1949-2000

	1949	1952	1965	1978	1980	1995	2000
Grain (10 000 tonnes)	11 318	16 390	19 455	30 477	32 056	46 662	46 218
Cotton (10 000 tonnes)	44.4	130.4	209.8	216.7	270.7	476.5	441.7
Livestock (10 000 heads)	1 149	7 646	8 421	9 389	9 525	15 862	15 152
Meat (10 000 tonnes)	220	338.5	551	856.3	1 205.4	4 265.3	6 124.6
Fisheries (10 000 tonnes)	44.8	166.5	298.4	466	450	2517	4 278

The opening-up and reform policy undertaken since 1978 greatly released productivity. Farming, livestock and fisheries production increased tremendously. Compared with perennial farm produce shortages in the past, farm production today is balanced and even produces a surplus in some years. In 2000, China's total grain output amounted to 462 million tonnes, an increase of 51.6 percent against 1978 and 3.08 times that of 1949. Total cotton output reached 4.417 million tonnes, an increase of 1.03 times relative to 1978 and 9.94 times that of 1949. Total output of oil products reached 29.55 million tonnes, an increase of 5.67 times that of 1978 and 10.52 times that of 1949. In 2000, total production of pork, beef and mutton reached 61.25 million tonnes, an increase of 6.15 times against 1978 and 26.84 times against 1949. Milk output reached 9.191 million tonnes, an increase of 8.5 times against 1978. Egg output was 22.43 million tonnes, 3.2 times more than 1985. In 2000, China's total fisheries output was 4 278 million tonnes, an increase of 8.18 times against 1978 and 94.19 times that of 1949.

Farmers' income and living standards improved

While agricultural production and rural economy achieved continuous development, farmers' income level has also been upgraded dramatically. In 1978, farmers' per capita net income was only 133.6 yuan, but rose to 2 253.4 yuan by 2000.

Rural reform brought about rapid all-round growth of farm production and greatly improved the food supply situation. Urban and rural residents have solved subsistence problems and enjoy well-off lives. Dietary variety and quality are notably adjusted and improved. Comparing 1998 with 1978, the grain directly consumed by farmers tended to be stable and other food consumption increased: fats

and oil product consumption more than doubled, meat consumption nearly doubled, egg consumption increased over four times and fishery products more than three times.

FIGURE 1
Increase of grain production, 1949-2000

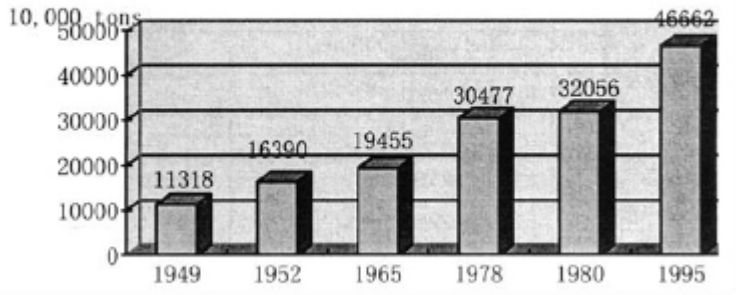
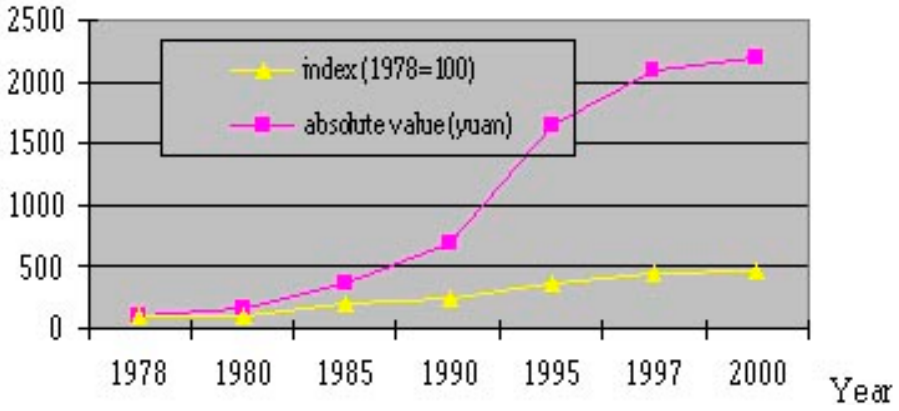


FIGURE 2
Increase of farmers' per capita income 1978 to 1998



While the quantity and quality of food consumption is improving, other living expenditures witnessed even faster growth. In 2000, farmers' per capita living areas was 24.8 m^2, a rise of 16.7 m^2 compared to 1978. In particular, half timber and concrete housing construction increased significantly. Today, for every 100 rural families, there are 101.71 television sets, an increase of 7.6 times compared to 1985, 21.58 radio/tape recorder sets and 28.58 washing machines. Appliances such as refrigerators, video recorders, cameras and air conditioners have become necessities in ordinary families. In 2000, the Engel's coefficient of rural residents was 50.1, down by 14.6 percent compared to 1978.

TABLE 2
Change of farmers' per capita net income, 1978-2000

	Absolute value (yuan)	Index (1978 = 100)
1978	133.6	100.00
1980	191.3	138.99
1985	397.6	268.94
1990	686.3	311.20
1995	1577.7	386.67
1997	2090.1	437.44
1998	2162.0	456.78
1999	2210.3	473.54
2000	2253.4	483.48

Agricultural infrastructure conserves water

Agricultural infrastructure focused on farmland water conservancy strengthened agriculture's capability to fight against natural disasters. China has suffered from frequent floods. In 1949, there were only six large-scale reservoirs, 17 medium-scale reservoirs and a few small reservoirs and dams. For 50 years, China's government and people have painstakingly built water conserving engineering works for flood control, irrigation, drainage and water supply.

While focusing on control on major rivers and lakes, the state also enhanced control of medium and small rivers and construction, maintenance and management of reservoirs to build capacity to counter both floods and drought. By the end of 1997, embankment projects countrywide totalled 251 000 km. Some 84 800 reservoirs have been built with a total capacity of 45.83 million m^3, of which 3 031 reservoirs are large- and medium-scale – an increase of 3 008 or 130 times that of 1949.

TABLE 3
Change of farmer per capita net income, expenditure and living areas, 1978-2000

	1978	1990	1995	2000
Net income (yuan)	133.6	686.3	1577.7	2253.4
Living expense (yuan)	116.0	584.6	1310.4	1670.1
Food	79.0	343.8	768.2	866.7
Weight (%)	68.1	58.8	58.6	50.1
Living Area (m^2)	8.1	17.8	21.0	24.8

In 2000, effective irrigated areas totalled 53.9 million ha, an increase of 2.4 times the 15.93 million ha irrigated in the 1950s. Of this, 38 million ha were ensured of harvest irrespective of drought or excessive rain. Of areas subject to waterlogging, 80 percent (over 20 million ha) have been harnessed. Of total saline-alkali farmland areas, 70 percent (over 5 million ha) have been transformed.

In the 1990s, water-saving irrigation was widely applied, together with the extension of dripping irrigation, spraying irrigation, leakage prevention in canals and water transmission pipelines, so that the efficiency of irrigation is largely improved. To date 13 million ha of farmland has been served with water-saving irrigation with effective irrigation efficiency up to 34 percent.

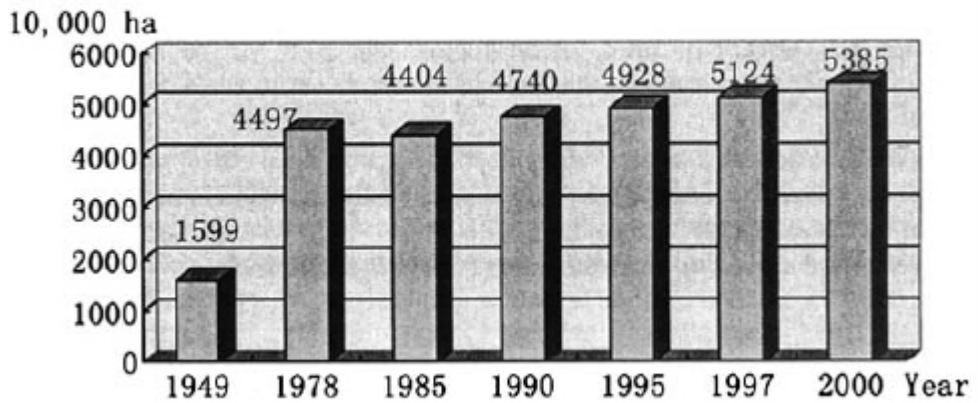
TABLE 4
Changes in reservoirs and irrigated areas, 1949-2000

	1949	1978	1985	1990	1995	1997	2000
Reservoirs (number)	-	84 600	83 219	83 387	84 775	84 837	-
Large/medium reservoirs (number)	23	2 516	2 741	2 865	2 980	3 031	-
Irrigated Areas (10 000 ha)	1 599	4 497	4 404	4 740	4 928	5 124	5 385

Water and soil conservation efforts have produced striking results. Through sand control and land transformation projects, some provinces like Shanxi, Ningxia and Xinjiang have become oases with beautiful landscapes in the place of formerly harsh agro-ecological environments. Forty percent of areas affected by erosion – over 70 million ha – have been reclaimed.

Basic agricultural production improvements have contributed greatly to better harvests. These achievements are closely linked with investment and development in water and land.

FIGURE 3:
Increase of irrigated area, 1949-2000



REVIEW OF CHINA'S WATER AND LAND DEVELOPMENT AT THE NATIONAL LEVEL

Comprehensive agricultural development (CAD): China's fundamental policy

Basic goal and its policy of comprehensive agricultural development

Comprehensive Agricultural Development (CAD) was initiated in 1989. It is a policy and strategic measures to conduct macro agricultural adjustment, improve the stamina of and promote sustainable agricultural development. Its goal is to improve overall production capability of main farm produce with grain as the core, to increase the effective supply of farm produce and strengthen the vigour of agricultural development through comprehensive development and rational use of water and land resources. CAD is targeting development of water and land resources as well as comprehensive development and utilization of all other kinds of advantage resources in the development areas.

There are three major methods of water and land resources development: (i) comprehensive management is used to transform mid- and low-yielding cropland to eradicate disadvantage factors for the yield, to improve production condition, increase material and technical input, rationally adjust structures of industry and products, improve labour productivity and yield, and to follow a track of tangible development; (ii) pipeline wasteland resources are reclaimed step by step to make up the decrease of cropland and other land used for agriculture. Through extensive development, a group of new agricultural production bases will be shaped; and (iii) through development of advantage resources, exploring multiple business operations and market-oriented pioneer projects based on resource advantages. Industrial development turns out to be the pioneer project motivating production bases to also promote production of hundreds of households. In this way, agriculture and the rural economic structure will be optimized to improve farmers' income.

The goal of comprehensive agricultural development mainly lies in three aspects: (i) through comprehensive management measures, agricultural production and ecological environment will be improved. Meanwhile, high quality cropland with high and stable yields will be constructed and the capability of fighting against natural disaster will be enhanced; (ii) through extension of agriculture technical achievements, relying on technical advancement, the overall agricultural production capability will be steadily improved to ensure the effective social supply of major farm produce with grain as core; (iii) through multiple business management, market exploration and agricultural operations vertical integration will be promoted and farmer incomes in the project sites will be gradually increased.

After more than one decade practice, comprehensive agricultural development has become an important component of policy supported by the government under the socialist market economy.

Investment in comprehensive agricultural development (CAD) and its effects

Statistics indicate that CAD investment from 1988 and 2000 amounted to 115 billion yuan: 33 billion was CAD funding from central finance, 30 billion was counterpart funding from local finance, 17 billion was earmarked funding and 35 billion was contributed by rural collectives and masses. Additionally, farmers provided 9 billion workdays, equivalent to about 50 billion yuan.

During the past ten years, CAD has made remarkable achievements and has contributed greatly to improved comprehensive agricultural production capability, promoted rural economic development, expedited the realization of two fundamental changes in agriculture and the rural economy and speeded up the process of agricultural modernization, which can be summarized as follows:

To strengthen infrastructure construction and enhance stamina of agricultural development

Agricultural, water conservancy, forestry, science and technology and biological measures have been applied in CAD projects. Current land resources have been comprehensively managed in terms of mountain, water, cropland, forest and road. High level basic cropland has been achieved: the land use rate, productivity, and the capacity to resist natural disaster has improved remarkably. Through development, standard cropland with stable high yields has been produced which can be irrigated, drained and operated in efficient configurations. Forest belts, connected canals and thoroughfares are part of expedited agricultural modernization. Signaficant accomplishments were registed during CAD's first 11 years: by 1998, 259 million mu of mid- and low-yielding land was transformed; 29 million mu of wasteland suitable for cultivation was reclaimed; and 20 million mu of grassland was improved. In addition, 7 119 small-scale reservoirs were newly built or enlarged – increasing national capacity by 3.13 billion m^3; 42 800 thousand drainage and irrigation stations were newly built; 1.14 million km of canals were built or restored; 314 500 km of farm service roads were built and 782 000 cultivators and weeding machines were purchased. At the same time, 226 million mu of effective irrigated area were newly expanded and improved; 132 million mu of drained area were increased and improved and 157 million mu of soil were improved. Apart from the above, 36 million mu of forest belt for cropland were afforested and cropland forest nets were made in all completed CAD project sites. Moreover, some components of agro-ecological projects – such as water conservancy projects, shelter forest on the upper reaches of the Yangtze river and afforestation on Taihang mountain – were included in the CAD scheme and achieved sound ecological benefits.

To improve overall agricultural productivity for effective supply of staple farm produce

By the end of 1998, the CAD programme had improved grain productivity by 47.72 million tonnes accounting for 40 percent of the total newly increased grain production in the same period. Meanwhile the newly increased cotton, oil-plant, meat and hay productivity was 1.11 million tonnes, 2.35 million tonnes, 4.56 million tonnes and 3.9 million tonnes respectively. This has played an important role in reliving the contradiction of supply and demand of our major farm produce, especially promoting the grain production to a higher level.

To explore the effective way of "two essential transforms" in the economy of rural China to actively create advantage conditions of realization of agricultural modernization

Comprehensive agricultural development (CAD) not only adhered to land development and management practice, but also stressed technical level improvements. Five percent of total investment was allocated for technical funding in development areas in most provinces which had accumulated 2 billion yuan in the past 11 years. Some 768 000 mu of quality seed base were constructed, 19 500 agricultural technical service systems were installed, 83.35 million man time of farmer technicians were trained to promote technical achievement applications in agriculture and improving the level of intensive agriculture. Project sites fully utilized all kinds of agricultural resources to actively develop multiple business operations and processing industry of farm produce and by-products, to explore effective ways on vertically extending agricultural integration and increasing the added value of farm produce. Vertical agricultural integration is market oriented, focusing on benefits, making arrangements regionally, industrially managing, operating in large scale and serving society are gradually becoming the direction of project sites development in future. In 11 years, 4.48 million mu of cash forests were afforested, 1.88 million mu were developed for aquaculture, more than 118.35 million livestock and poultry had been raised and 2 586 processing enterprises for farm produce and by-products were established.

Farmer incomes in the project sites increased remarkably and speeded the process of achieving economic and material well-being

> Comprehensive agricultural development not only increased the effective supply of farm produce, but also substantially improved farmers' income. Per capita farmer's income in the project sites is 260 yuan higher than in non-project sites (500 to 600 yuan). The highest even reached 1 000 yuan. In this way the development goal of increasing production and income was achieved. Furthermore, the projects emphasized efficient grass roots social service organization and established varied economic entities and pioneer enterprises to enhance social service functions, improve the strength of the collective economy and promote development of relevant industries. The proposals made important contributions to absorbing large numbers of rural surplus labour, increasing farmers' income, further stabilizing the household responsibility contract system, perfecting combined and separated double track operation systems, speeding up the timeline toward being well-off and achieving this goal.

Achievements of cropland and water conservancy infrastructure in the Ninth Five-Year Plan

Irrigation areas were increased and pump irrigation and drainage was improved. Sixty-four million mu of irrigation area was added, with an annual increase of 12 million mu – the most rapid period since 1980. There was 820 million mu of effective irrigation area in 2000: 5 683 irrigation areas reached to 10 000 mu countrywide to a total irrigated area of 367 million mu – of which 402 are large irrigation areas covering 290 million mu. Irrigation pumping power capacity in China was developing steadily and rose to 74 million kW irrigating 553 million mu. Some 3.98 million pumping wells were dug covering 226 million mu of irrigation area. Efficient irrigation facilities, strengthened service functions and newly and largely increased irrigation areas enhanced the capacity of agriculture against drought, distinctly improved production conditions and promoted agricultural structure adjustment, increasing agricultural production and farmer income.

Existing irrigation facilities were transformed to water saving types. Some 115 million mu was covered by newly increased water saving engineering in the Ninth Five-Year Plan period which reached 250 million mu by late 2000. Meanwhile, 250 million mu adopted new scientific irrigation measures and water saving methods, such as the shallow/wet/basking method for paddy rice and irrigating the crop itself in the cultivated land instead of flooding irrigation along furrows and surface of the land. In order to support development of water saving irrigation, subsidy and interest discounted loans were offered by the government to encourage farmers to adopt water saving techniques and equipment.

Waterlogging and salinized cropland management. China has 367 million mu of waterlogged cropland. By the end of 2000, the primarily controlled area reached 314 million mu (85 percent), of which 182 million mu had one waterlogging incident in five years. Initially transformed salinized areas reached 88 million mu (76 percent).

Rural drinking water supply nearly resolved. The problem of drinking water supply for 51 million rural Chinese was resolved during the Ninth Five-Year Plan with 1.25 times more than in the Eighth Plan. Some 7 600 water supply engineering projects were built for towns and townships with a daily water supply capacity of 17 million tonnes and 70 million beneficiaries. Rural water supply development has improved water supply for the rural population, expedited poverty eradication and small town construction and promoted overall development of society and the rural economy.

State investment in agricultural water conservancy totalled 7.4 billion yuan in the Ninth Plan: Some 3.6 billion yuan was used for water saving engineering projects and 3.8 billion yuan was for

human and animal drinking water. A further 23 billion yuan was spent on water conservancy construction in CAD projects (calculated in the investment).

TABLE 5
Effective irrigation areas to indicate changes by different years

Year	Effective irrigation area (10 000 ha)	Year	Effective irrigation area (10 000 ha)
1949	1599.0	1993	4864.6
1965	3203.6	1994	4875.9
1975	4612.1	1995	4928.1
1980	4488.0	1996	5038.1
1985	4403.6	1997	5123.9
1990	4740.3	1998	5229.6
1991	4782.2	1999	5315.8
1992	4859.0	2000	5385.1

Construction of production bases of grain and other farm produce

Since 1978, the household responsibility contract system was generally applied in rural China, greatly motivating the production enthusiasm of farmers. Grain production rapidly jumped to 350 and 400 billion kg from 300 billion kg. However, from 1985, fluctuations occurred. It was urgent to explore alternatives to further develop agriculture, to improve overall agricultural productivity and to increase the commodity rate of farm produce.

From 1983, the state invested 300 million yuan in pilot commodity grain base construction in 60 counties of 11 provinces with better grain production conditions, e.g. Heilongjiang, Jilin, Inner Mongolia, Hunan, Hubei and Jiangxi. This was the starting point of agricultural commodity base construction.

As pilot base construction was initiated during an important transition period of agricultural development, it was endowed with a development opportunity by China's history. A new way was found to further expand agricultural production.

By 2000, state investment amounted to 2.079 billion yuan for building 1 397 agricultural commodity bases: 1 212 million yuan for construction of 1 009 grain production base counties; 558 million yuan for 252 quality cotton production base counties; 175 million yuan for 77 sugar production base counties and 140 million yuan for 59 oil plant production base counties.

Through unremitting efforts in the 16 years, a remarkable achievement was made in building agricultural commodity base counties, which mainly embodied a gradual efficiency of agricultural infrastructure, distinct improvement of agricultural production conditions, resistance capacity greatly enhanced against natural disasters, gradually completed quality seed breeding and agricultural technical extension. The base construction strongly promoted the steady growth of major farm commodities such as grain, cotton, oil and sugar. The commodity rate was gradually raised. The established commodity grain base area accounted for 46 percent of total commodity grain areas sown nationwide, however, grain production took up 56 percent of the total. The commodity grain provided by the bases accounted for 65 percent of the total in China. The cotton base growing area and production was 70 percent and 80 percent respectively of China's total. The yield per mu was 5 kg

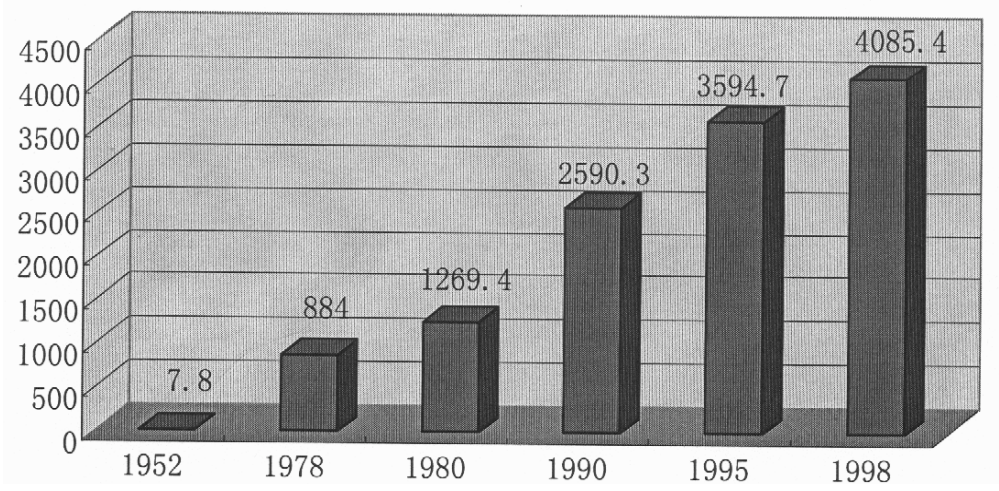
higher than China's average. The sugar material base growing area and production was 32 percent and 38.6 percent of China's respective total. Sugar output was 42 percent of the total. In general, the production base counties became the key to agricultural production, with pioneering counties establishing "agriculture of high yield, high efficiency and high quality", having stable production and demonstrating the technological vitality which increasingly played a larger role in operating the rural economy.

In 1993, owing to the importance attached to it by the Chinese Government, building agricultural commodity bases was included in the Chinese Law on Agriculture, setting a milestone of construction of agricultural commodity bases.

Inputs of chemical fertilizer and other agricultural production materials

In 1949, there was almost no chemical fertilizer use nationwide; only 78 000 tonnes of chemical fertilizer were applied in 1952. By 1978 it rose to 8.84 million tonnes at an annual increase of 30.9 percent. In the 1980s, chemical applications increased remarkably, reaching 41.46 million tonnes in 1998, 3.7 times higher compared than 1978.

FIGURE 4
Chemical fertilizer used (equivalent in active ingredients), 1952-2000 (10 000 tonnes)



In 2000, the total amount of pesticide used was some 1.28 million tonnes. The low toxic and high efficient pesticides applied had a further growth. Since 1980s, the use of plastic film in farming has developed rapidly; now, it is popular nationwide. Plastic film use in 2000 amounted to 1.33 million tonnes; compared with 0.482 million tonnes consumed in 1990, it increased by 1.8 times. In 1952, 1978 and 2000, the consumption of electricity in the rural areas was 50 million kWh, 25.31 billion kWh and 242.13 billion kWh respectively.

OUTLOOK OF DEVELOPMENT OF WATER AND LAND RESOURCES IN CHINA

Since the late 1990s, agriculture and rural economy have had the following major developments:

Supply of farm produce: Farm produce has progressed from an overall shortage to a general balance with relative surpluses of structural and regional natures;

Growth pattern: Agricultural development has shifted from being labour intensive to capital and technology intensive;

Development target: Agricultural development has shifted from seeking maximum farm production to maximum returns from both domestic and overseas markets;

Income generation: Ways and means of farmers' income generation have shifted from relying mainly on increased production and higher prices of farm produce, especially that of grains, to relying mainly on a diversified economy in agriculture and non-agriculture.

This shows that the development of agriculture and the rural economy has entered a new stage. Agriculture with higher returns and ecological development have been given top priority. The government has formulated important action plans to develop and protect water and land resources.

Comprehensive agricultural development (CAD) at a new stage

Direction of development

To meet requirements for developing agriculture and the rural economy at this new stage, the Second Joint Meeting on Comprehensive Development of National Agriculture was held in May 1999 and determined the following changes in CAD guidelines:

- The practice of taking a combination of transforming low- or medium-yielding farmland with opening up wasteland suitable to farming as the major means to raise crop yield will be changed to taking the transformation of low- or medium-yielding farmland as the major means to improve crop yield while minimizing reclamation of wasteland or trying not to open up any land. To this end, CAD should be combined with protection of ecology and the environment;

- The practice of seeking higher production of major farm produce shall be changed into active restructuring of agriculture for developing "high yielding, good quality and high efficiency agriculture" by relying on progress in science and technology. CAD emphasis should be placed on four priorities: developing production bases for quality grain and for quality feed grain, water-saving farming and ecological development.

According to principles established at the Second Joint Meeting, the Office of Comprehensive Development of National Agriculture (OCDNA) made three adjustments to future CAD priorities:

- Comprehensive agricultural development will focus on infrastructure development to transform low- and medium- yielding farmland as the key element. It was further decided that higher grain production alone should not be overemphasized, but that more attention should be given to consolidating and improving CAD production capacity to lay a solid foundation for agricultural restructuring. Starting from 2000, reclamation in CAD project areas is forbidden;
- CAD projects will focus on developing the production basis of quality wheat and fodder grain as well as on water-saving farming and ecological development; and

- Increased attention will be given to applying research programme results. To make greater use of progress in science and technology, and to explore effective use of agro-high technology in agricultural production, demonstration projects were set up beginning in 1999, including projects for seed improvement, water saving, facilitating horticulture and precision agriculture. OCDNA also decided that a proper share of the additional finances allocated annually during the Tenth Five-Year Plan will be identified for these demonstration projects.

Arrangement of development zones and focuses

Key state zones of comprehensive agroresources development with farmland as their focus include:

- Three key state development zones. The first is located in the middle and lower reaches of the Yangtze and Huaihe rivers, and consists of the Jiang-Han plain (Yangtze and Hanshuir river basins), the Dongting Lake basin, the Boyang Lake basin, the Jiang-Huai basin (Yangtze and Huaihe river basins), the Taihu Lake basin and the Sichuan basin. This zone has a subtropical climate, optimum water supply and sunlight for producing grain, cotton, oil crops and fruits. The largest gain producer, it has double cropping of rice and wheat, or double cropping of rice, or triple cropping of paddy rice and dryland rice annually. However, grain production levels vary from area to area within the zone. Low biased to medium- or medium biased to low-yielding farmland is of higher potential in increasing output and optimum cost-effectiveness. In addition, most medium-yielding farmland and some low-yielding farmlands are in some basic condition for transforming into stable, high yielding farmland. Such land could produce more commodity farm produce so long as vigorous efforts would be made to do so.

- The second zone is in the Huang-Huai-Hai basin (the Yellow, Huaihe and Haihe river basins), consisting of plains in front of Yanshan and Taihang mountains, low-lying plains in Hebei, Shandong and Henan provinces (including the Yellow river delta) and the Huang-Huai plain (the Yellow and Huaihe river plain). This zone is mainly a temperate monsoon climate. One of China's major producers of grain, cotton, oil crops and animal products, it is characterized by dryland farming of two crops a year. Water shortages are a very serious problem. Grain yields may be raised by 50 to 100 kg through water conservancy, water-saving farming and transformation of low- or medium-yielding farmland. It is also possible to raise animal husbandry to a new development stage through developing feed crops and the comprehensive use of stalks and straws.

- The northeast China plain is the third region – including two national key development zones, the Songhuajiang and Liao He river plain and the three-river plain (Nenjiang, Helongjiang and Mudanjiang rivers). Located in a mild climate zone with proper precipitation and mild temperatures suitable for crops such as wheat, corn and soybean, it is an important commodity grain-producing area. Single cropping productivity is not as good as in the regions above, but the land area is relatively large and per capita arable land and barren land suitable for agriculture is abundant and the commodity production rate is high. Flood and low temperatures are serious concerns here. Crop cultivation is extensive; if land here is improved and its management strengthened, it would have great potential for yield increases.

Key provincial zones of comprehensive agricultural resources development based on arable land:

This zone includes 19 development areas of the mid- and lower reaches of the Pearl river, the Fenhe and Weihe river valleys, Ningxia and Inner Mongolia irrigated areas, Hainan island, central and southern Guangxi, central Yunnan and Guizhou, the Hehuang area of Qinghai, the Yaluzhangbu Jiang river region, the Nujiang and Lanchangjiang rivers in Tibet, corridor areas of the Yellow river, the plains of Nanyang, Gangdi in north Hubei, Jinqu plain-Xiaoshouning area of Zhejiang, the northwest area of Fujian, hilly areas of central Jiangxi, the hilly areas of central Hunan, Panxi area, the northern Weihe river and eastern Gansu and the Yili-Taibei irrigated area of Xingjiang. These areas are dispersed in 531 counties of 20 provinces and autonomous regions: Sichuan, Guangdong, Guangxi, Shaanxi, Shanxi, Inner Mongolia, Ningxia, Hainan, Yunnan, Guizhou, Qinghai, Tibet, Gansu, Jiangxi, Hunan, Hubei, Henan, Zhejiang, Fujian and Xingjian.

The development target is: (i) to improve low and medium yielding farm fields. The major types of existing low or medium yielding croplands are characterized by drought and short water supply, poor land and slope land. The emphasis of land improvement development is smaller areas and projects with potential for increased yields and basic conditions for implementing relevant regional improvement projects, (ii) to improve low yield water surfaces with a focus on suburbs of large and medium sized cities, (iii) the integrated exploitation, utilization and improvement of land focusing on integrated construction of farm fields, water, forests, roads and villages.

Key grassland resource development zones:

This region includes eight development zones in overlapping agriculture and animal husbandry areas of northeast China, e.g. the grasslands of northern Inner Mongolia, Ganzhi, Aba, southern Gansu, Qinghai Lake, Yili and Alietai. The region involves 113 counties in eight provinces and autonomous regions: Inner Mongolia, Liaoning, Jilin, Helongjiang, Sichuan, Gansu, Qinghai and Xingjiang. Usable natural grasslands cover 1.264 billion mu and 1.088 billion mu in animal husbandry and semi-animal husbandry areas (28.6 percent and 33.1 percent respectively).

Yili has the highest quality grass. Its high quality/high yielding and medium quality/high yielding grassland is over half its area. High quality/low yielding and high quality/medium yielding grassland comprise much of the overlapping areas of agriculture and animal husbandry in the northeast China and northern Inner-Mongolia grasslands (30.5 percent and 15.4 percent). Medium quality/medium yielding grassland takes a big share in the grasslands of Aba, Ganzhi and Gannan (36.1 percent). Medium quality/low yielding grassland is a large proportion of Qinghai Lake grassland (38.8 percent), followed by high quality/low yielding grassland (24.9 percent). Quality grass in Alietai is the poorest: low yielding grassland (42.4 percent), high quality/low yielding grassland (29.7 percent). The grazing capacity per unit area in Aba, Yili and Ganzhi is highest; the overlapping agriculture-animal husbandry area in northeast China and southern Gansu ranks second while the northern Inner Mongolia, Qinghai Lake and Alietai grasslands are poorest.

Major measures for development: are to improve pasturage and to develop high standard sown pasture in agricultural areas where soil and water conditions are rather good with easy access to transportation. Where conditions permit, grasses can be introduced into farm fields, a combination of agriculture and animal husbandry. It is to adopt the measures of "agriculture fosters animal husbandry" and "cattle fattening at different locations" to promote economic development of animal husbandry areas.

Key development zone of subtropical hills:

This region encompasses three development zones in hills south of the Yangtze River, the hills of Zhejiang and Fujian and the hills of Nanling. This region involves 285 counties in 8 provinces and autonomous regions: Hebei, Anhui, Zhejiang, Jiangxi, Hunan, Fujian, Guangdong and Guangxi. Total land area is about 602 000 km^2. Within this region, hills comprise over 80 percent while forest covers 550 million mu. Only 20 million mu of land has been used while 50 million mu has potential for further development. There are abundant forest and fruit resources: it is an ideal growth zone for subtropical perennial forest and fruit and important production basis of tea, citrus, tung oil, fir and *Mao* bamboo.

Exploitation should be based on securing grain production and transforming slopes to fully use the resources of gentle slopes to engage in vertical development of tea, fruit, economic forest, fast growing forest and water and soil conservation forest, and to upgrade and transform low yielding poor orchards and gradually develop new orchards. It is to encourage the relocation fruit trees from fields where it is suitable for grain production to the slopes, in order to resolve the contradiction of land use by grain and by fruit. It is to actively develop pasture, and to improve the natural pasture in a coordinated way and step by step. It is to develop with great effort fast growing and high yielding forest in order to realize the strategic adjustment of lumber production to the southern part of the country and to alleviate the ecological and forest resource crisis in northeast, southwest of China and Qinghai-Tibet Plateau.

Coastal shoal development zone:

The region encompasses 184 coastal counties in 11 provinces and autonomous regions, namely, Liaoning, Hebei, Tianjing, Shangdong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Guangxi and Hainan. The total area of shoal is 53 million mu, of which 20 million mu is shoal above tide, the utilized and to-be-utilized areas are 40 percent and 60 percent respectively. The shoal located in the interval areas of tide is 33 million mu, and the utilized and to-be-utilized areas are 30 percent and 70 percent respectively.

The development of shoal should uphold the principle of "three combinations" of crop farming, animal raising (especially acquaculture) and protective forest system along the coastal line and to fully tap the advantages of resources. The key areas to be reclaimed are the coastal areas of northern Jiangsu Province, the gulf areas around Bohai sea, the delta area of the Yellow River, the southern coast of Qiangtangjiang River mouth, the delta area of Pearl River and the delta area of Liaohe River. The key areas to develop acquaculture in shallows are Liaodong peninsular, Shangdong Peninsular and Bohai Sea, the gulf of Zhejiang and Fujian and the coastal areas of Guangdong, Guangxi and Hainan. The construction of coastal protection forest will focus on the coastal lines of southeast and south China.

Tropical crop development zone:

In China, the tropical and the south of subtropical climate zone include 5 provinces and autonomous regions, namely, Hainan, Guangdong, Guangxi, Yunnan and Fujian, with 191 counties and a total land area of 460 000 km^2, which is a treasure land for tropical crops that is not easy to have. The total acreage of tropical crops in China is over 11 million mu while the major crops are rubber, coffee, cocoa, coconut, palm, cashew nuts, spices, medical herbs, kenaf, pepper and cassava. Sugarcane is the major advantageous cash crop with acreage of 14 million mu accounting for 75 percent of the national total. The major tropical and subtropical

fruits and economic forest are banana, pineapple, logan, lychee, citrus fruits and other tropical fruits unique to tropical areas.

The development of tropical crops should base on the domestic market while aiming at the international market, and focus of this endeavor is to develop those products that have considerably significant shortage of supply in the domestic market, that have comparatively high efficiency and that can yield high return of foreign currency. The coastal areas should take fully advantage of the economic and technological conditions and use high quality products to participate in the international competition. While in the hinterland, it is to focus on the construction of production basis and to develop those products that have a short supply in the domestic market, and when conditions permit, to actively participate in competition of the international market.

Key development zone of poverty alleviation and ecological improvement

This region includes four zones of the hilly and gullies areas of loess plateaus, Qinglin-Bashan mountains, Wulingshan mountains and the limestone mountains of southwestern China. This region encompasses 302 counties in 12 provinces, namely, Shanxi, Shaanxi, Ningxia, Gansu, Henan, Hubei, Hunan, Sichuan, Chongqing, Guizhou, Yunnan and Guangxi. Among the 302 counties, 109 national poverty counties have been listed in the national "Eight-Seven" (using eight years to eradicate poverty over seven million population) Poverty Alleviation Programme.

These four areas suffer the gravest soil erosion in China. Erosion in the gully areas of the loess plateaus accounts for 80 percent of the total while the erosion scale is 2 000-20 000 tonne/km^2 annually, and in some places, it reached 35 000 tonne/km^2 yearly. In the Shanxi and Shaanxi sections of the eastern Losses Plateau, the density of gullies is usually 5-7 km/km^2 while the gully area takes up 40-50 percent of the total area. In the Ningnan-Longzhong areas of the western loess plateau, the density of gullies is 2-5 km/km^2, and gullies take up 30-40 percent of total area. In Qingling-Bashan mountains, arable land with slopes greater than 25 degrees comprise 40 percent of total arable land. In Shanglou of Shaanxi province, eroded soils comprise 80 percent of total land area while in southern Gansu, soil erosion accounts for 62 percent of total land. In Wulingshan mountain, soil erosion worsened 3 to 4 times than that of 50 years ago. Soil erosion in the limestone areas of southwestern China caused serious stone desertification (coverage of forest and grass less than 30 percent) accounting for one tenth of total land area. Semi stone desertification (forest, bush and grass coverage of 30 to 70 percent) accounts for 13 to 20 percent and in some places reaches 45 percent. The four zones are located in the upper and middle reaches of the Yellow and Yangtze rivers, so there is great strategic significance to strengthen water and soil conservation and river management.

The main tasks for the development and harness are as follows: actively carrying out the transformation of middle and low-yielding farmland with the emphasis on turning slop land into terrace in order to realize the goals of per capita basic farmland of one mu or more than half mu for high and stable-yielding land; conducting three-dimensional development for hilly area and develop diversified operation with forest and animal husbandry as well as economic forest as the priority areas; strengthening construction of shelter-forest and proactively carrying out the integrated control of small drainage area.

MANAGEMENT OF LAND RESOURCES

Due to the fact that our country suffers a serious shortage of cultivated land in terms of per capita, the per capita cultivated area in coastal areas has been lower than warning line of 0.8 mu set by FAO.

Therefore, with respect to the protection of land resources, our Government has adopted even more severe measures. The main practices are as follows:

Specialized departments are established. In 1998, the Ministry of Land Resources was established to strengthen the management of state land resources with an emphasis on land resources protection.

Great attention has been attached to the policies. Since our country is in serious shortage of natural resources on average per capita basis, therefore our Government sets the principles like preciously and rationally use of land as well as truly protect of the cultivated land as the basic state strategies. All these have played an important role in the following aspects, namely: correctly handle the relationship between economic development, protection of cultivated land and ecological system, further strengthen the protection of land for agricultural purpose, especially protection of cultivated land, strictly control the total amount of land used for construction and optimize the land use structure, enhance the intensive use level of land resources, stabilize and increase grain productivity as well as guarantee the land use requirements for economic development.

Procedures for basic farmland protection should be strictly observed that balance on the total amount of cultivated area be maintained. By 2005, the projection that the total cultivated area in China will be not less than 128 million ha and total basic farmland area be not lower than 108.6 million ha can be guaranteed. The new mechanism to protect cultivated land should be in place and perfected. The guidance and constraint mechanism on the relationship between land supply and land demand should be established and the planned quota for diverting farmland is distributed in a rational manner, so as to increase the use of reserved land. During examination and approval of diverting farmland, the plan for making up land and the implementation of financial resources must be examined. Therefore, the regulation of making up another piece of land for occupying one piece of farmland should be rigorously observed and the establishment of cultivated land reserve system be explored in an active way. In accordance with the quota of total acreage defined in "Overall Planning on Land Use", the responsible systems of leaders' objective for protecting cultivated land at different levels should be set up and the policies of rewards and penalties in connection with the land protection and benefits carried out at various local government levels. It is our task to implement the regulations on readjusting the land benefits contained in the "Law on Land Administration". The forecast and warning system for protecting cultivated land is requested to be set up and the social monitoring mechanism on land use and management is formed.

Land use for construction of key water conservancy, transportation and energy projects is to be guaranteed. At present, projects which have strong government support, such as water conservancy building for agriculture and forest, development of transportation and communication, urban infrastructure construction, improvement of electric network in urban and rural areas, economical housing construction and ecological development. The land use requirements for all of that shall be guaranteed. General construction projects should make full use of the preserved land for construction purpose and idle land. It is to strictly carry out the state industry policies, such as: "Catalogue on the Ban of Land Supply" and "Catalogue on the Constraints of Land Supply". The standard system on land use for construction projects will be gradually perfected and implemented in order to avoid duplicated construction at low level. Pre-examination of land use for construction projects should be well conducted and the principle of guiding the construction projects for not occupying or occupying less cultivated land be promoted.

The reform and improvement of the land use system in urban and peri-urban areas shall be promoted so as to push forward the urbanization progress. An overall plan for construction by stages will promote and accelerate the transformation of old cities. Through readjustment of land use structures and by making full use of existing available land, the circumstance of low efficientcy in the use of land in urban and peri-urban areas can be changed. It is to carry out well the management of

land use for construction in small cities and towns and rigorously control the occupation of farmland and forestland for construction purpose in villages and townships. Under the precondition of protecting cultivated land and ensuring the legitimate rights of farmers, a rational solution to the issue of land use in cities and towns is to be found. Rural residents will be guided to move to the central areas of villages and townships, while township enterprises are encouraged to locate themselves to the small industry areas. It is to promote the integrated system for villages. And, the management on the combined development of cities and townships as well as the land use for the development districts should be strengthened.

The advantages of regional resources are to be brought into full play and land use structure and pattern readjusted in a rational manner. In accordance with the different land requirements for industrial areas, highly concentrated areas for cities and towns, specialized farm products bases and ecological protection areas, it is requested to rationally readjust the land use structure and pattern. By strengthening the guidance and monitoring management on land use for agricultural production structure readjustment, it is to form the mechanism on readjustment and utilization of agricultural land in a reasonable and orderly way, so that the destruction on cultivated land can be avoided. The areas for over cultivation and inning should be returned into forest, grass and lakes in a planned way. The cultivation in slope areas along big rivers and other fragile ecological areas should be totally and quickly returned. It is to actively carry out the sand prevention and control measures.

In future, an annual investment of about 200 million yuan will be used for monitoring land resource changes, land leveling and preparation as well as resumption of cultivation.

FERTILE SOIL PROGRAMME

Agriculture and rural economy in our country have stepped into a new development period. To ensure the state food security, increase tangibly the farmers' income, enhance the efficiency and benefits of the utilization of water and land resources and intensify the sustaining-strength of agricultural sustainable development are the main objectives and tasks for the agricultural development in the new stage. However, the present situation of cultivated land quality, scientific fertilization technology and the level of infrastructure facilities as well as the establishment of laws and regulations are far more inadequate in terms of pushing forward the agricultural production and development. The main constraints are: firstly, the serious imbalance between the use and maintenance of cultivated land, which results in the obvious decline of soil fertility; the average content of organic matter in soil of cultivated land across the country is only 1.8 percent, while that of organic matter in dry land soil is only 1 percent. In the fragile ecological areas of the west and northeast, soil fertility decline is even worse; secondly, the input benefit of fertilizer has not been raised dramatically. Total fertilizer volume in China ranks first worldwide. However, due to the irrational structure of varieties and big difference in fertilization in different regions, the utilization rate of fertilizer during the season is always staggering at around 30 percent, which has big difference in compare with the world advanced level. The issue of waste is also serious; thirdly, due to the fact that farm land and water environment are severely polluted, the difficulty of raising agricultural products' quality is becoming bigger.

For the above reasons, the country, therefore, decided to carry out the Fertile Soil Programme. The main objectives are to comprehensively strengthen the building of cultivated land quality and increase soil fertility; optimize fertilization pattern in order to enhance the utilization rate of fertilizer; integrated use of waste resources and improve the farm land environment; equip with soil and fertilizer analysis facilities and improve the socialized service system.

Guiding principles and objectives

Guiding principles

The principles of overall planning, emphasis on key and pilot projects and steadily extension are to be carried out. With a view to the problems of cultivated land utilization and fertilizer application in our country, efforts shall be made in order to realize the following directions: by optimizing allocation and rationally utilizing of soil and fertilizer resources, through the means of the progress of science and technology and innovation, with the realization of technology commercialization and socialized service as the effective way, and by strengthening the cultivated land quality, extending balanced fertilization and enhancing the facilities' level of basic equipment for soil and fertilizer, an integrated service system for soil testing and formula, compound fertilizer, supply and application of fertilizer will be gradually set up. An overall plan for the utilization benefit of cultivated land quality and fertilizer application as well as the enhancement of agricultural product production and its quality can be realized, so as to promote the sustainable agricultural development.

Object

The first object is to realize 'two transfers' for the utilization model of soil and fertilizer resources. Cultivated land resources will be transferred from extensive operation into intensive operation of high efficient development, utilization and fertilizer accumulation. Utilization of fertilizer will be shifted from low effectiveness modal to high effective and accurate modal. The second object is to realize 'four enhancements' for the effect of soil and fertilizer utilization, namely, soil fertility will be increased by one grade, utilization rate of fertilizer by 10 percent productivity of grain by one grade and the share of soil and fertilizer in the contribution to the agricultural production by 10 percent. The third object is to adopt 'four measures' for soil and fertilizer, namely, the network of information monitoring and processing on soil, fertilizer and soil moisture, scientific formula of fertilizer, specialized formula fertilizer production and the whole process of technical service.

Priority tasks

The implementation of "Fertile Soil Programme" places its emphasis on the strengthening of cultivated land quality building, extension of balanced fertilization technology, basic facilities for analyzing soil and fertilizer and the role of state project demonstration.

Cultivated land quality building.

First, the input of organic fertilizer should be increased. The emphasis will be on organic accumulation, production and basic facilities establishment, in order to push forward the specialization, commercialization and mechanization production of organic fertilizer. Second, the level of scientific fertilization should be enhanced and the rate of fertilizer utilization increased. The key is to combine the organic and inorganic fertilizer together, guide the fertilization through testing soil and providing formula, extension of new variety of fertilizer and deep placement of fertilizer. Third, efforts shall be made to improve the middle and low-yielding farmland, reform tillage system, transform the slope land and build high standard of farmland. As for the transformation for the most difficult middle and low-yielding farm land, the overall ability of the cultivated land for degradation resistance and production level can be raised through the building of permanent farm works and integrated control as well as increasing the capacity of soil for preserving moisture and fertility. Fourth, soil degradation and farmland pollution should be prevented. The priority work is to conduct the soil fertility testing and monitoring, intensify the management of pollution for the farm land, collect and reuse the plastic film residue, make good use of human and animal wastes and stalk resources in order to protect ecological environment in agriculture.

Extension and application of technology of balanced fertilization.

To do this, first, a nutrition investigation on arable land is required to indicate the quality of our arable land and primary productivity of the soil, which will be in service for soil improvement, fertilizer cultivation, returning the farm land to forest and grassland and soil degradation management, especially for the extension of balanced fertilization technology. Secondly, more effort needs to be given to promote a comprehensive social service system in terms of technology and materials, in which strengthening management for special fertilizer is a major task. This requires us to provide fertilizer varieties needed in agricultural production in due course and places through fertilizer distribution stations (plants) as well as to offer good after-sale service, such as technical guidance on fertilizer application. Thirdly, establishing a number of key demonstration zones for balanced fertilization technology helps us promote and extend this technology vigorously and make better perform out of fertilization model plots areas.

Preliminary conditions for soil and fertilizer development.

The key parts are "two systems and one comprehensive demonstration base"—National Network System for Soil Chemical Content Monitoring and Information Management, National Trial System for New Varieties of Fertilizer and New Technology for Soil & Fertilizer Development, and a comprehensive demonstration base for national "Fertile Soil" Project.

This project needs to be treated as follows: In region's distribution, based on different laws of soil distribution, climate features and cropping and application patterns, the guidance given under this project should be varied in different categories and regions determined by the project construction plan. In terms of processing, it needs to be carried out in a way of trial base first, breakthrough in key parts second, and comprehensive promotion last. An estimated 100 million RMB of investment will be made for this project in the next 5 years.

BUILDING AGRICULTURAL WATER CONSERVANCY IN THE TENTH FIVE-YEAR PLAN

Objectives of the Tenth Five-Year Plan

Water-saving is the focus in agricultural water conservancy in the Tenth-Five- Year Plan. With the aim to assist readjustment in agricultural structure and increase farmer's income, more work needs to be done in innovation and reform of current water facility technology and agricultural water management system as well as operational mechanism to increase utilization efficiency on agricultural water, to improve rural service function for water conservancy, and to push agricultural water conservancy development forward into a new stage.

Main tasks

The first is to increase land area of water-saving irrigation by 100 million mu to 350 million mu nationwide, to make a further reduction of 16 m^3/mu in national average water consumption per unit in accordance with the Ninth Five-Year Plan and to cut down water consumption on land with agricultural production value of 10 000 RMB by 450 m^3. The second is to increase the new irrigated area by 30 million mu so as to make the total irrigated area reach 850 million mu nationwide. The third is to complete transformation of water-saving facilities with the focus on water efficiency in large irrigation areas. About half of those areas will be enabled to be fully equipped with water-saving facilities and to benefit from water-saving farming, production increase and efficiency improvement. The fourth is to transform 50 million mu of waterlogging-prone, saline and alkaline land and to take control of waterlogging frequency to as low as once per five years in most areas vulnerable to waterlogging. The fifth is to build a total of 13 million of water cellars, pools and water tanks to ensure water supply for average farming land per capita (0.5 mu) in case of drought in western regions. The sixth is to basically solve the drinking problem for 24 million people, which is not addressed successfully in the Poverty Alleviation Programme (the programme involves the plan to make 80 million people get rid of poverty by using 7 years). The seventh is to increase water supply capacity for villages and towns by 35 million tonnes/day and enable 75 percent villages and towns to use supplied water through newly-built and transformed water supply facilities in those areas. The eighth is to expand irrigation area of fodder grass, cultivated pasture and natural grassland by 5 million mu, and to establish a number of water-conserving demonstration projects in pastoral areas.

BUILDING NATIONAL ECO-ENVIRONMENT

Eco-environment is an important factor for human existence and development as well as the foundation for economic and social development. In order to restore and protect our eco-environment, according to actual condition of our eco-environment, the central government formally issued the "National Plan for Eco-environment Building" in November 1998. As a long-term plan of 50 years, it indicates the tasks and objectives for eco-environment building campaign in three different stages. This is the most comprehensive plan ever issued by the State Council in terms of eco-environment building with the longest enforcing period. This plan is of great significance in terms of trees & grass planting, soil erosion management, desertification prevention, natural forests & grassland protection and eco-agricultural development. This is a substantial readjustment in the strategy of our modernization drive, and an actual act to carry out relevant international agreements.

It is stated in the plan that China's eco-environment building will experience three stages – short-, middle- and long-term. The respective goals in these stages are:

Short-term goals

That is to use 10 years (2001-2010) to take control of man-made factors to avoid newly-emerged soil and water erosion and to restrain desertification. The specific objectives are: by 2010, to make an extra area of 600 000 km^2 affected by soil and water erosion get controlled; to improve desertified land of 2 200 ha, and to increase the percentage of forest cover to above 19 percent (measured at above 0.2 in canopy density), to transform sloping land of 6.7 million has and to returning farming land of 5 million ha to forest; to develop farming land with high standard and forest network of 13 million ha; to grow a total of 50 million ha of newly cultivated and improved grassland; to establish a number of water-saving, dryland farming and ecological agricultural projects; to improve inhabiting environment for wildlife and plants and to make natural reserves take up 8 percent of the total territory. A preventive monitoring and protection system in key eco-environmental zones will be established.

Mid-term goals

After eco-environment deterioration gets contained, this goal requires us to try every effort to make a substantial improvement on national eco-environment within 20 years (2011-2030). The major objectives during this period are: to bring above 60 percent of manageable land with problem of soil and water erosion under control in different grades and to make a remarkable progress in the key areas of soil and water erosion treatment, such as the upper and middle reaches of Yellow River and Yangtze River; to improve desertification area of 40 million ha; to increase forest area by 46 million ha and to make the percentage of forest cover as high as above 24 percent; to make natural reserves of different categories account for 12 percent of the total territory; to ensure popularization of the technologies for dry-land water-saving farming and eco-agriculture; to realize 80 million ha of newly cultivated and improved grassland and to restore about half of grassland affected by degradation, desertification, and alkalization. The eco-environment in the key treatment zone will be on the track of benign circle.

Long-term goals

That is to use another 20 years (2031-2050) to establish a benign ecosystem to basically meet the demand of sustainable development. Its major objectives are: to ensure primary treatment of all manageable areas affected by soil and water erosion, afforestation on all land appropriate for commercial forestry, a rational mix of woods and trees varieties and a percentage of national forest cover of over 26 percent; to transform most sloping land to terraces; and to realize overall restoration of grassland affected by degradation, desertification and alkalization. The national eco-environment will see an obvious improvement and beautiful mountains and rivers will appear in most regions.

In the Ninth Five-Year Plan, the central government invested 34 billion RMB in infrastructure construction for eco-environment, nine times more than the 3.65 billion RMB applied in the Eighth Plan. It is estimated that the financial investment made in the Tenth Plan will be no less than that in the Ninth Plan.

CONCLUSION

Although a new period begins when the current global economy is under dual restrictions from both resources and markets, the resource economy is still playing a decisive role. Under the consistent strategy of sustainable development, it is important to be fully aware of our actual condition and potentials of agricultural resources and the evolution of agricultural eco-environment and to transform the resource advantage to economic and market advantages, which will be very much significant to increase farmer's income, promote sustainable agricultural development and ensure the food security nationwide.

We will intensify the effort in the development and protection of agricultural resources continuously in the days to come. Meanwhile, foreign investors are welcome to take part in our ecosystem construction and resources exploitation, especially in the development of western regions.

Investment in land and water in the DPR Korea

INTRODUCTION

The Democratic People's Republic of Korea (DPRK) is located on the Korean peninsula of continental northeastern Asia. The peninsula has a total area of 222 209 km^2, of which the Democratic People's Republic of Korea holds 122 762 km^2 or more than 55 percent. The DPRK shares borders with China and Russia on the north bounded by the Amnok and Tuman rivers respectively.

The population of the DPRK is 22 550 000 and it has an annual growth rate of about 1.5 percent. The population in unevenly distributed, being concentrated primarily on the western plains. Two-thirds of the population live in cities and the rest in rural areas. The majority of the rural people work on cooperative farms. Life expectancy is 66.8 years. The primary school enrolment rate for both girls and boys is 100 percent. The secondary school enrolment rate is 100 percent for girls and 100 percent for boys. All adults are literate: 100 percent of both men and women.

The DPRK's gross domestic product is US$10.273 billion while per capita GDP is US$458. The Government of the Democratic People's Republic of Korea has consistently put the attainment of self-sufficiency in food production as a primary task – by developing agriculture (mainly by investment in land and water) – and has directed every effort to carrying out this task.

At the beginning of the year 2000 the government called on its people to make decisive progress in building a strong and prosperous country and announced national priorities regarding agriculture, power generation and transport. The government emphasized that the highest priority should be given to the development of science as one of the means for a breakthrough in the country's current economic difficulties.

Agriculture is intensively managed, but has always been constrained by the fact that Korea is largely mountainous, with only 20 percent of its land suitable for agricultural production. Winters are harsh and the growing season is short.

The economic problems that affected industry at the beginning of the 1990s also affected agricultural production during the decade. Although government made efforts to counter such limitations through appropriate research, planning and intensive management, ageing agricultural infrastructure, equipment and fuel shortages also negatively affected production.

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But the economic problems that affected industry in the early 1990s also affected agricultural production due to political and economic sanctions, pressure from outside forces and continued natural disasters. Fertilizer production from local plants, for example, virtually ceased because of the shortage of inputs and energy. This in turn drastically affected agricultural yields.

SUCCESSIVE NATURAL DISASTERS CAUSE SIGNIFICANT LOSSES IN ALL SECTORS

Since 1995 shortages have been exacerbated by a series of natural disasters caused significant damage to DPR Korea's agriculture and to its capacity to feed its people. Natural disasters from 1995 to 2001 occurred in unfortunate succeession, one after another:

- In 1995, floods caused overall damage estimated at US$15 billion by DPR Korea government officials. Of this amount, US$925 million was damage to the land itself, US$1 billion in damage to irrigation facilities; US$225 million in damage to pumping stations and agricultural structures; US$1.3 million in damage to rivers and streams; US$1.575 million n losses to forests; and 1.9 million tonnes of grain lost;

- In 1996, flood damage was lower than in 1995 but still severe with an overall loss valued at US$2.27 billion. Of the total, the agricultural sector sustained US$782 million in losses, with 29 760 ha of arable land submerged, 27 300 ha of land lost to erosion and 15 000 ha of land rendered unusable by being covered over by low quality siltation;

- Drought was the problem in July 1997 with 465 862 ha of arable land sustaining damage. Of this 107 000 ha were paddy fields while 358 700 ha of general agricultural land was rendered non-productive, Grain damage of 1.7 million tonnes was registered, together with the loss of 80 000 head of livestock. So severe was the drought that 40 617 ha if forest cover was lost;

- Some 2.8 million people were affected only a month later (August 1997) when a severe tidal wave damaged 288 800 m of sea dykes, and seawater flooding damaged 107 625 ha of arable land and ruined 0.7 million tonnes of grain;

- Floods occurred again in 1998, with overall damage calculated at US$2 billion, including US$862 million in the agricultural sector and damage to 14 817 ha of arable land and 355 000 tonnes of grain;

- May 2000 brought drought again – and damage to 400 000 ha of arable land. Paddy fields amounting to 160 000 ha were damaged by drought, while serious insect infestation affected 530 000 ha and 0.96 million tonnes of grain were damaged.

- A typhoon followed in August 2000, with overall damage amounting to US$6.1 billion. The agricultural sector sustained US$165 million in damages while arable lands registering US$136 000 in damage together with 400 500 tonnes of grain damage.

- The chronicle of disaster culminated in August 2001 by heavy rainstorms that resulted in US$4.8 billion in rain and water damage. Some 85 000 ha of grain (including 58 000 in paddy) was lost (180 000 tonnes) and 28 000 m of river dyke infrastructure;

The historically catastrophic losses of 1995 – US$15 billion – impacted arable land, irrigation facilities, pumping stations and agricultural infrastructure to flooding, effectively destroying Korea's overall economy. Moreover, from 1995 to 2001 natural disasters ranging from flood, drought and

typhoon, compounded by frozen, heavy rain and tidal waves annually was responsible for some US$2 to US$6 billion in agricultural field losses.

PERFORMANCE ON INVESTMENT IN LAND AND WATER

Difficulties in agriculture brought on by economic problems continue to seriously undermine DPR Korea's domestic food production. The effects of these tragedies have accumulated over several years and are now probably more significant than in the past in constraining production.

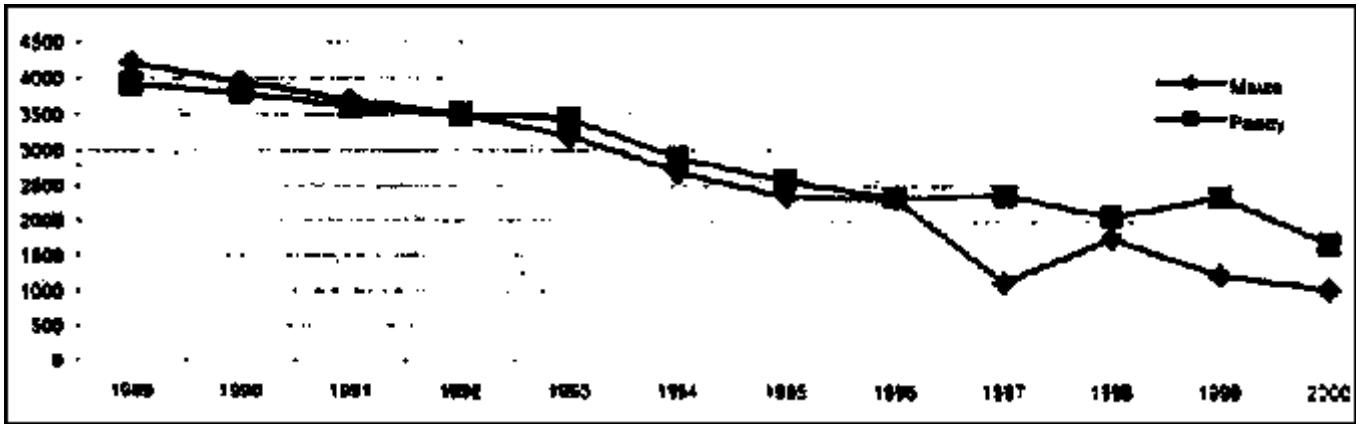
There are serious problems in the provision of electricity and fuel, which in turn have greatly reduced the capacity of farms to reserve and deliver adequate supplies of water, while mechanization and the provision of transport have also been severely curtailed and there is a chronic shortage of fertilizers and other agrochemicals.

These in turn have severely limited necessary farm operations reducing the ability of co-operatives to cover water shortages, through increased irrigation, in adverse years and reduced potential productivity.

Machine hours are declining as more and more become irreparable, constraining key agricultural operations, while aggregate fertilizer use has dropped in recent years to well bellow basic requirements to maintain reasonable soil nutrient levels.

Although the international community has assisted the country bilaterally and through UN agencies to rehabilitate agriculture and through donations of fertilizers and other inputs, the levels have been well short of what is required to maintain agriculture and food production sustainability.

In view of all these problems, the output of rice and maize has fallen sharply. The corresponding decline in fertilizer use and production of paddy and maize in illustrate in Chart 1 and Figure 1, which clearly indicate the direct relationship between limited fertilizer supply and the DPRK's falling rice and maize harvests since 1989.

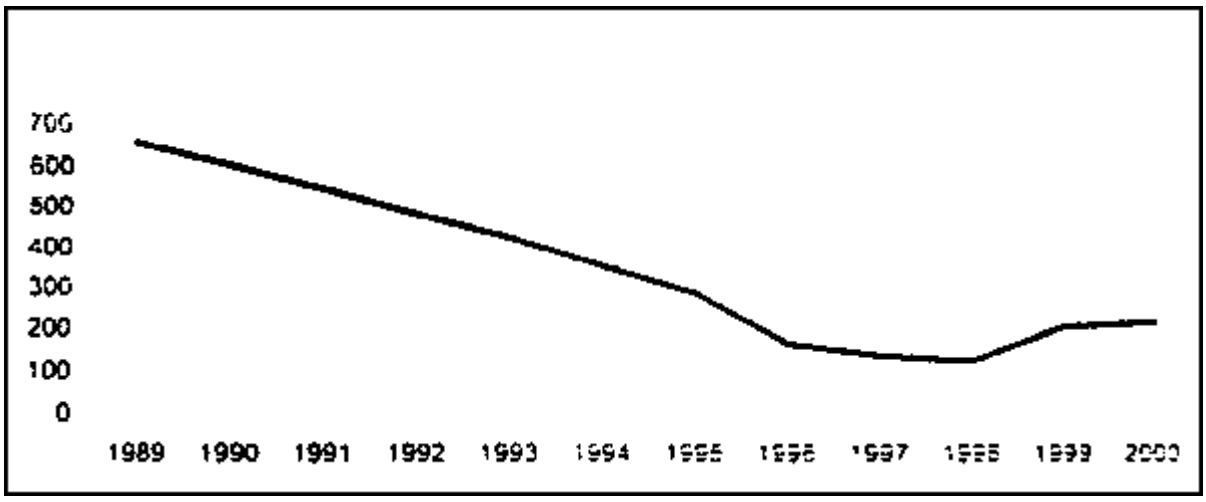


Available land resources

Arable land in the DPRK is extremely limited due to the topography of the country. Of some 12 million ha of land overall, 80 percent is mountainous and unsuitable for agriculture. The main land use systems comprise: (i) annual cropland; (ii) perennial cropland; (iii) permanent meadows and pastures; and (iv) forests and woodlands.

About 1.85 million ha of land are used for agriculture, of which 300 000 ha are under permanent crops (fruit, mulberries), 600 000 ha are used for paddy production, 650 000 ha for maize and 200 000 ha for vegetables.

Of the remaining area, 50 000 ha are under wheat, buckwheat and barley and 40 000 ha are planted in potatoes. The area under cereals covers over 80 percent of Korea's arable land. The limited availability of arable land and the government policy of food grain self-sufficiency has led DPR Korea to opt for high intensity agriculture. Soils are poor (pH 5 to 7, with organic matter only at 0.5 to 1.5 percent) – and the risk of erosion is high in uplands.



All flat land is irrigated for paddy production. Sloping land below 16 is planted in maize and other field crops, while steeper hillside land (16 is planted to mulberry and fruit trees. Hilltops are usually forested. Each rural household is entitled to a plot of up to 90 m^2 for its own use. Such plots are intensively cultivated with beans, potatoes, cabbage, and maize and support poultry and small livestock.

National plans for current and future land needs

Field reconfiguration permits high-efficiency mechanization of agriculture

In order to cope with these circumstances, the Government of the DPRK together with the United Nations Development Programme (UNDP), initiated the Agricultural Recovery and Environmental Protection (AREP) programme which targets the replacement of emergency humanitarian aid with development cooperation by the year 2002 by producing three times more food (6 million tonnes).

The AREP proposals were formulated by an FAO/UNDP Sector Studies and Project Formulation Mission in 1998. AREP costs were estimated at US$344 million over three years (1999-2001) including a food-for-work programme in forestry. In addition, the government would invest US$374 million – of which 287 million in hard currency is mainly for feedstock and fertilizer imports. So far since the formulation of AREP in 1998, approximately US$130 million has been delivered bilaterally through UN agencies and NGOs.

The government proposed improving field configurations as an important policy for the revolution in agriculture and also concentrated efforts on the land readjustment in such granary provinces as Kangwon, North Pyongan and South Hwanghae from 1999 through the year 2001 to expand and standardize arable land for high efficiency application of farm machinery.

As a national campaign with farmers, workers from all provinces and the Korean People's Army, the government completed reconfiguration projects for 300 000 ha of fields in Kangwon province in 1999 and 500 0000 ha in North Pyongan province in 2000 and 500 000 ha in South Hwanghae province in 2001.These provinces are in mountainous places with high yielding soils but erosion, soil fertility depletion, salinity, alkalinity and acidic soils were increasingly unable to meet the challenge of producing the required yields.

Improving agricultural field and crop design and layout in this manner is a great transformation of nature for the prosperity of the country, a patriotic work of lasting significance. Land rezoning is essential for boosting gram production. This is a good way to increase grain production in countries with limited arable land. Proper realignment of fields is also important for effecting comprehensive mechanization of rural agricultural economies.

The government invested heavily not only in field layout projects during construction but also by providing hundreds of tractors for the three provinces and enough organic and chemical fertilizer so that each province produced 2.5 to 4 times the crop yield compared to the previous year. Economies have been realized by minimizing the amount of fuel necessary for transporting food grain from other provinces.

To increase grain production where farming areas are limited, the government put forward a new policy of double cropping. The two-crop farming system is based on growing different short-growth-period crops in different periods on the same land in one year. Introduction of the two-crop farming system has increased Korea's land utilization rate as well as per unit area of land. In parallel with the above activities, the government promoted initiatives for quality seed production. Potato cultivation was also expanded in consideration of the characteristics of each region and its soils on the principal of right crop on the right soil at the right time.

Government targets were relatively constant during the past decade: an annual target at around 580 000 ha for rice – although in 2000 the target was reduced to 535 000 ha – which produced from 4.5 tonnes/ha in good soil, allowing 45 000 ha to be diverted to other low yielding crops, such as buckwheat, sorghum and millets, which are less susceptible to drought.

For example, in 1999 the government reported a significant fall in the area of maize planted from an average of around 650 000 ha in the early 1990s to 496 000 ha. The decline was attributed to substitution of potatoes for maize. Together with double cropping, such substitution is generally viewed as an important strategy to increase food supplies, particularly during the lean season beginning in June.

The targeted area to be planted under the 1999-2000 double crop programme was 100 000 ha of winter wheat/barley and 23 000 ha of spring barley/wheat.

The target for potato cultivation in 2001 was 187 000 ha of which 103 000 ha was planted as the main crop and a further 77 000 ha as a double crop, though low yields were anticipated because of the continuing heavy drought.

At the same time, the government ensures production of organic fertilizer as the first and foremost method for improving soil fertility. With a correct understanding that producing organic

fertilizer in quantity is essential for increasing crop yields, the government is producing organic fertilizer to enrich by the application of rich organic fertilizer through a mass movement and to apply it to the newly realigned fields as planned. Government agricultural authorities are also giving more attention to the supply of chemical fertilizers to every province.

Available water resources

Water resources are abundant in the DPRK. Renewable water volume is estimated at 23 000 million m^3, the surface flow at 13 000 million m^3. Substantial investment has been made in reservoirs, canals and pumping systems for irrigation of paddy and maize. Some 1.46 million ha (79 percent of agricultural land or 94 percent of arable land) has infrastructure for irrigation but only half of the design area is on average irrigated. Not more than 1.2 billion m^3 water is actually used for irrigation. Operation of the important West Sea Barrage which serves 300 000 ha is hoped to be a major contribution towards this objective.

Irrigation is primarily from surface water. All but 300 000 ha of irrigation areas are served by pumping from rivers. This involves considerable lifts using large amounts of electrical and diesel energy. Groundwater is rarely used. Paddy land is irrigated by flood basin, uplands by both furrow and sprinkler. Furrow irrigation in uplands is often done on sloping land favouring erosion.

National plans for current and future water needs

In order to reach its goal of self-sufficiency in rice and maize, the DPRK Government has focused on investment in water development. Water supply is critical to this effort.

As one step toward solving DPR Korea's water supply challenge, the government is carrying out a large-scale project of 150 km to streamline natural waterways from Kaechon to Lake Taesong in the western part of the country. From an engineering standpoint it is a challenging project, and it was undertaken under difficult economic conditions from the year 2000 as a national campaign project. The Kaechon-Lake Taesong waterway project would increase grain production by 300 000 tonnes in South Pyongan province. With its completion, water will flow naturally into paddy and nonpaddy fields, making many pumping stations unnecessary. It would make it possible to dispense with many electric motors, transformers and water pumps and considerably economize in electric power.

In the Kaechon-Lake Thaesong waterway project, it is important to concentrate on digging water tunnels and finish them as soon as possible. Tunnelling takes a long time to complete and therefore heavy equipment for tunnelling is mobilized.

To cope with energy shortages, construction of small-medium hydro power stations was successively conducted in the eastern and northern parts of the country, enabling rural areas to benefit from power for heating and irrigation.

The government has conducted to built thousands of reservoir and irrigation ponds so on in every where in the country while repairing irrigation facilities damaged by consecutive natural disaster.

POLICY DIRECTION IN AGRICULTURE

In the economic sector, the government in early 2000 called on its people to make decisive progress in building a strong and prosperous country, announcing the national priorities of agriculture, power generation and transport. It emphasized that the highest priority should be given to the development of science as one of the means for breaking through the current economic difficulties.

The great leader of the Korean people, General Kim Jong Il, always pays deep attention to solving the problem of food supply for the Korean people. While on frequent on-the-spot guidance to rural areas, he sits together with peasants to share views on farming and teaches them the ways and means to increase agricultural production.

The government is establishing strategies to solve the food problem mainly by investment in land and water, revitalizing and modernizing the national economy in a short period, and increasing expenditure for their implementation. The government also directs great effort to reforestation work to provide favourable agricultural environment.

Taking full notice of diversified agricultural development, Democratic Korea is constructing fish farms and breeding high productivity fish, wherever government has water sources, and vigorously pushing ahead with a movement to increase the production of livestock including grazing animals.

CONCLUSION

In the year 2001 as well, the government is striving to clear away the consequences of continuing natural disasters, such as drought and unseasonably high temperatures, to raise agricultural production by investment in land and water.

Thanks to the fighting sprit of the Korean people advancing in unity with the leader under any difficulties, agricultural production will soon reach the levels achieved in the pre-disaster period.

The DPRK Government appreciates and thanks the United Nations Food and Agriculture Organization for Asia and the Pacific for the sincere support to the Korean people in their striving to normalize agricultural production and solve the country's food problem with about US$23.3 million of farming materials and technical aid from 1980 to 2001.

The Korean people’s struggle to raise agricultural production to the normal level will surely produce good results.

Investment in land and water: India's experience

INTRODUCTION

India continues to be a predominantly agrarian economy with the majority of its population depending on agriculture for livelihood. The agriculture sector contributes about one-fourth share in GDP. Population growth and fragmentation of limited agricultural land on the one hand and limitations to increasing productivity through traditional methods of cultivation on the other, posed a severe constraint to agricultural growth in India's first decade of independence. The Green Revolution brought in by introducing high yielding varieties and systematically developing irrigation led to a breakthrough in raising productivity to meet the food demands of the increasing population. Per capita availability of food grains improved from 395 grams per day in 1951 to 459 grams per day in 1999 (Agricultural Statistics, 2001). But the challenge of maintaining the momentum in growth of food production keeping pace with population growth and making agriculture a viable source of income generation in the wake of globalization of the economy continues to receive serious attention of all concerned with agriculture. Ensuring accessibility of food to all citizens is another dimension of the challenge to be tackled simultaneously by augmenting avenues of employment, especially in rural areas.

Agriculture being the major occupation in rural areas, available land must be optimally utilised to increase production and provide livelihood to the people. Agricultural land consists of cultivated areas, fallow land, cultivable wasteland and land under miscellaneous trees has remained at 184 million ha for several years. The net planted area expanded from 118 million ha in 1950-1951 to 142 million ha in 1997-1998 by bringing more land under cultivation. Yet some 24 million ha of cultivable land are kept fallow year after year due to delayed and insufficient rainfall or due to lack of resources for cultivation (Land Use Statistics, 2001). Thus, there is scope for increasing net planted area to increase production and create additional employment.

Net irrigated area has increased from 21 million ha in 1950-51 to 55 million ha in 1997-1998 and gross irrigated area grew from 23 million ha to 73 million ha. Cropping intensity was 133 percent. Gross cropped area increased from 132 million ha in 1950-1951 to 191 million ha in 1997-1998. Overall cropping intensity with reference to 142 ha of net sown area is 134 percent and is almost the same as the cropping intensity of the irrigated area. This is contrary to the expectation that multiple cropping would be more prevalent in irrigated areas.

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India's population crossed the billion mark at the turn of the millennium, rising from 361 million in 1950-1951. Population growth picked up momentum at the dawn of independence due to

reduced mortality rates owing to better health facilities and improved living conditions. Consequently, cultivated land became more fragmented and the average size of an operational holding declined to 1.57 ha in 1990-1991 (Agricultural Statistics, 2001). This trend will lead to operationally inconvenient land parcels unless the proportion of the agricultural work force also decreases in accord with reduced share of agriculture in GDP, as expected in a developing economy. According to census data, the proportion of agricultural workers in the total work force declined from 69 percent in 1951 to 59 percent in 1991.

Net Value Added (NVA) is the value of output less intermediate consumption and depreciation. Agricultural per-worker NVA has risen from Rs. 566 (US$12) per annum in 1951 to Rs. 12 423 (US$264)[2] in 1991. The corresponding increase in the non-agricultural sector is from Rs. 975 (US$21) to Rs. 32 287 (US$686) during the same period (Annex I) (National Accounts Statistics, 2001; National Accounts Statistics-Back Series). Apart from disparity in earnings between agricultural and non-agricultural workers, agricultural labourers get a smaller share of NVA as wages, which further reduces per capita income. As agricultural labourers are also observed to have more dependants to feed, poverty and food insecurity are often more pronounced in the case of rural labourers.

Food production in India is greatly influenced by the vagaries of monsoon and other weather conditions. About two-thirds of cultivated land depends on rain for water, and annual fluctuations are extreme. Considerable investment in agriculture and rural infrastructure is required to offset fluctuations in production due to aberrant weather conditions and to ensure achieving the target level of growth in production. Assured irrigation is a key factor in bringing about stability in production. Thus, investment in water in the form of implementing major, medium and minor irrigation projects, and development of watersheds in rainfed areas assumes primary importance in agricultural investment. Apart from increasing productivity and production, these investments help in providing employment to the rural population and increase their income.

INVESTMENT IN LAND AND WATER

Investment leads to capital formation consisting of additions to fixed assets and increases in stocks of inventories. Additions to fixed assets (also called fixed capital formation) are assets produced as outputs from production processes that are themselves used repeatedly or continuously in other production processes for more than one year. Accordingly, land is not a fixed capital asset because it is not an output of a production process. Improvements made to non-produced assets such as land and costs associated with transfer of landownership are also taken as fixed capital formation. Another component of capital formation, a change in inventory stock, is change in the inventory of intermediate goods, finished goods and semi-finished goods held by an enterprise. Fixed capital formation and changes in stock constitute Gross Capital Formation (GCF).

The National Accounts Statistics is India's central source for information on capital formation. Capital formation in private sector agriculture includes minor irrigation work, construction of bunds and farmhouses, machinery and equipment acquisition, increments to livestock, and development of orchards and plantations. Public sector investment in agriculture is predominantly in irrigation projects. Capital formation in land reclamation, soil conservation, afforestation and watershed development are undertaken by the public sector, and constitutes about 20 percent of public investment. Such items are shown in National Accounts as capital formation in public administration,

[2] A conversion rate of Rs. 47 per US$1 is used throughout.

and are not included under agriculture according to accounting procedure (Sources and Methods, 1989). Public sector investment in developing rural infrastructure, e.g. building rural roads, rural electrification, agricultural markets, storage facilities, education, training and extension work, also induces private investment in agriculture. Such investments provide employment to the rural population to earn their livelihood during the off-season. Though these expenditures are predominantly meant for agricultural development and progress increasingly over the years, they are not included as capital formation in the agriculture sector in the National Accounts. To get a clear picture of agricultural investment, a committee is identifying all investment components, which assist capital formation in agriculture. However, the trend in agricultural capital formation according to the national accounting procedure in the past is as follows.

The GCF in agriculture rose from Rs. 52.58 billion (US$1.119 billion) in 1960-1961 to Rs.213.88 billion (US$4.551 billion) in 1999-2000 at 1993-1994 prices. The share of agriculture in the overall GCF of the economy decreased from 21 percent in 1951-1952 to 8 percent in 1999-2000 (Table 2). In comparison with the agricultural share of about 25 percent in the GDP, its share of 8 percent in GCF is disproportionate (National Account Statistics, 2001; National Account Statistics-Back Series).

TABLE 1 **Gross capital formation in agriculture at 1993-1994 prices**

Year	Total		Public Sector		Private Sector		Public Sector Share (%)
	Rs. (billion)	US$ (million)	Rs. (billion)	US$ (million)	Rs. (billion)	US$ (million)	
1960-1961	52.58	1 119	24.00	511	28.58	544	45.6
1965-1970	72.30	1 538	32.76	697	39.54	841	45.3
1970-1971	85.87	1 827	32.16	684	53.71	1 143	37.5
1975-1976	112.23	2 388	41.85	890	70.38	1 497	37.3
1980-1981	142.33	3 028	73.01	1 553	69.32	1 475	51.3
1985-1986	141.32	3 007	62.13	1 322	79.19	1 685	44.0
1990-1991	164.16	3 493	49.92	1 062	114.24	2 431	30.4
1995-1996	178.84	3 805	53.19	1 132	125.65	2 673	29.7
1999-2000	213.88	4 551	52.12	1 109	161.76	3 442	24.4

The private sector has a major share in agricultural investment as indicated in Table 1. The public sector contributed almost half of the investment in the initial decades of independence because of major irrigation development activities undertaken by the government. Since 1981, the public sector share has declined significantly. The contribution of the private sector keeps increasing to offset the decline in the contribution of the public sector. However, the necessity for increasing public investment in irrigation and infrastructure development has been emphasized in the National Agricultural Policy and the approach to the Tenth Five-Year Plan.

DEVELOPMENT OF IRRIGATION

Government's role as regards irrigation is to provide common facilities for the community. In direct agricultural investment, its main activity is creation of irrigation facilities. The multi-purpose hydrological projects executed in the initial decades of independence made possible the use of large-scale irrigation by farmers. Table 3 indicates changes irrigation since independence.

TABLE 2
Agricultural gross capital formation in 1993-1994 prices, terminal years of plan periods

Plan period	GCF of the economy (Rs. billion)	Agricultural GCF (Rs. billion)	Agricultural % of GCF
I Plan (1951-1956)	266	49	18.4
II Plan (1956-1961)	402	53	13.2
III Plan (1961-1966)	536	72	13.4
Annual Plans (1966-1969)	502	85	16.9
IV Plan (1969-1974)	722	103	14.3
V Plan (1974-1978)	834	131	15.7
Annual Plan (1978-1980)	980	174	17.8
VI Plan (1980-1985)	1 280	149	11.6
VII Plan (1985-1990)	1 595	134	8.4
Annual Plans (1990-1992)	1 729	150	8.7
VIII Plan (1992-1997)	2 526	183	7.3
IX Plan (1997-2000)*	2 685	214	8.0

*** Figures for 1999-2000**

TABLE 3
Net area irrigated according to source (thousand ha)

Year	Canals	Tanks/other sources	Tubewells	Other wells	Net irrigated area	Gross irrigated area	Cropped irrigated area	Cropping intensity overall (%)
1950-1951	8 295	6 580	n.a.	5 978	20 853	22 563	108.2	111.1
1960-1961	10 370	7 001	135	7 155	24 661	27 980	113.5	114.7
1970-1971	12 838	6 378	4 461	7 426	31 103	38 195	122.8	118.2
1980-1981	15 292	5 733	9 531	8 164	38 720	49 775	128.6	123.3
1990-1991	17 453	5 876	14 257	10 437	48 023	63 204	131.6	129.9
1995-1996	17 120	6 585	17 894	11 803	53 402	71 352	133.6	131.8
1996-1997	17 262	6 969	18 410	12 408	55 049	73 246	133.1	132.8
1997-1998	17 093	6 591	18 434	12 448	54 566	72 784	133.4	134.3

n.a. = not available

Area irrigation by canal has steadily increased from 7 million ha in 1950-1951 to 17 million ha in 1997-1998. Irrigated area through tanks, tubewells and other wells, which are the sources of minor irrigation, increased from 13 million ha to 37 million ha. The share of minor irrigation in the net irrigated area is 70 percent. Areas irrigated by tubewells and other wells have increased remarkably in

the minor irrigation sector. There is still an ample scope for increasing the use of tank and other sources of irrigation by developing watersheds. As already indicated, cropping intensity in irrigated areas and unirrigated areas remains almost the same. A possible reason is that water from irrigation sources is not available in all seasons for multiple cropping in most irrigated areas.

Investment in irrigation shows itself as capital formation in construction. While investment by government and individual farmers is covered in capital formation estimates in National Accounts, capital formation due to watershed development by non-governmental organizations (NGOs) and private agencies is likely to be omitted.

SOIL CONSERVATION

Land degradation takes place due to water erosion, wind erosion, ravine formation, waterlogging, shifting cultivation, forest degradation and other special problems. According to a survey conducted by the Indian Council of Agricultural Research (ICAR) 174 million ha of India's total 329 million ha are affected by land degradation. Water erosion is observed to be the major cause of land degradation. Government is implementing varied soil conservation schemes. It also helps to develop watersheds. The important schemes are described in the following paragraphs.

PROGRAMMES AND EXPENDITURES ON IRRIGATION AND SOIL CONSERVATION

Major, medium and minor projects

Government has undertaken various major, medium and minor irrigation projects, command area development and flood control measures during various plan periods. Expenditures incurred in these projects, including external aid received from donors such as the World Bank, EEC, JBIC-Japan, KfW-Germany, France and the Netherlands, are given in Box 1. External assistance received since 1997-1998 was Rs.7.46 billion (US$159 million) in 1997-1998; Rs.7.09 billion (US$151 million) in 1998-1999; and Rs.6.23 billion (US$133 million) in 1999-2000.

Sporadic studies in different parts of India conducted to assess agro-economic impacts and employment potential created with reference to particular projects reveal significant employment growth in the target areas. It was found that more labour was employed in irrigated areas as compared to unirrigated areas. The ratio of cultivators to labourers tilted in favour of labourers. The wage rate was found to be higher in the command areas as compared to unirrigated areas.

Most expenditures on major, medium and minor irrigation projects are spent on creation of capital formation in the form of construction. These expenditures are closer to capital formation figures due to public sector given by the National Accounts and as such they directly contribute to increase in capital formation in agriculture.

Land improvement and watershed development in rainfed areas

There is no denying the fact that green revolution of the 1960s has centred mainly on irrigated areas, and yield gaps between irrigated and rainfed areas are quite substantial. But evidence indicates that HYV technologies have been adopted even by farmers in rainfed areas, particularly where there is assured rainfall and the occurrence of floods and droughts are minimal. Nevertheless, the yield response to technology adoption in rainfed areas is much less, as compared to that in irrigated areas. Also, the yield variability is relatively higher. In fact due to low and uncertain yield response to new technology as well as low capital absorption capacity, rainfed areas have lagged behind in terms of

both technology adoption and productivity growth. As a result, the rainfed areas are associated with higher incidence of poverty. However, the facts that there is a limit beyond which irrigation potential cannot be increased and that irrigated areas have already reached a plateau in the adoption of available new technology, do compel us to look for alternative sources of agricultural growth, particularly in rainfed areas. In fact, India will have to increasingly harness the potentials of rainfed agriculture for ensuring the food and nutritional security of its growing population. Although the present food supply situation looks sustainable, the growing demand for foodgrains due both to population growth and rising income of the poor may compel us to look for alternative sources and areas of food production.

BOX 1

Major, medium, minor irrigation projects; command area development and flood control

Plan	Major & medium		Minor irrigation projects		Command Area Development		Flood Control		Total	
	Rs.	US$	Rs.	US$	Rs.	US$	Rs.	US$	Rs.	US$
I Plan (1951-1956)	3.76	80	0.66	14	-		0.13	3	4.55	97
II Plan (1956-1961)	3.80	80	1.42	30	-		0.48	10	5.70	121
III Plan (1961-1966)	5.76	123	3.28	70	-		0.82	17	9.86	210
Annual Plans (1966-69)	4.30	91	3.26	69	-		0.42	9	7.98	170
IV Plan	12.42	264	5.12	109	-		1.62	34	19.16	408
V Plan	25.16	535	6.30	134	-		2.99	64	34.46	733
Annual Plans (1978-1980)	20.78	442	5.02	107	-		3.30	70	32.73	696
VI Plan (1980-1985)	73.68	1 568	19.79	421	7.78	166	7.86	167	109.13	2322
VII Plan (1985-1990)	11.07	263	31.18	663	14.28	304	9.42	200	165.95	3531
Annual Plan (1990-1992)	54.59	1 161	68.80	1 464	6.15	131	4.61	98	82.15	1748
VIII Plan (1992-1997)	216.69	4 610	62.82	1 337	21.84	465	18.59	396	319.95	6807
IX Plan (1997-2002) (target)	429.68	9142	93.70	1994	28.87	614	29.39	625	581.64	12375

India's irrigation potential was estimated at 93 million ha for 1997-1998, of which 73 million ha of gross cropped area was already utilised. However, only 55 million ha of net sown area of the total 142 million ha are currently irrigated. For small irrigation projects, the average cost per hectare of irrigation potential created has risen sharply from Rs. 566 (US$12) in the First Five-Year Plan to Rs. 10 051 (US$214) in the Eighth Plan. The corresponding increase for large/medium projects was from Rs.1 200 (US$26) to Rs. 98 495 (US$2 096). This acts as a constraint to further augmentation of irrigation potential. In fact, all major irrigation projects are heavily subsidized. Their water use

efficiency is also very low because of low water rates, poor management and the inability to undertake further necessary investments to improve water use efficiency. In view of this, the watershed development approach seems to hold promise to irrigate rainfed land and provide other economic and ecological benefits.

A watershed is generally defined as a geohydrological unit or land area, the runoff of which flows in defined surface drains or streams to a common drain point. The watershed approach to development recognizes the interrelationships between soil and water and between upstream and downstream areas in development of water harvesting and conservation, appropriate land use, vegetative cover and other potentials of natural endowments to promote the socio-economic welfare of the people. All the while, ecological balance and sustainability is maintained.

Several governmental agencies, NGOs and external agencies promote watershed development projects in various rainfed areas. There are at least 13 major government programmes watershed and soil conservation development (see Table 2 on areas covered and budgets) including six operated by the Ministry of Agriculture:

- *National Watershed Development Project for Rainfed Areas (NWDPRA);*
- *Soil Conservation in Catchments of River Valley Projects (RVP);*
- *Soil Conservation in Catchments of Flood-prone Rivers (FPR);*
- *Reclamation of Alkali Soils;*
- *Alkali Land Reclamation and Development Project with EEC assistance; and the*
- *Watershed Development Project in Shifting Cultivation Areas (WDPSCA)*

The Ministry of Rural Development operates three programmes: the Drought Prone Area Programme (DPAP), the Desert Development Programme (DDP), and the Integrated Wastelands Development Programme (IWDP).

The Ministry of Forests and Environment has two programmes: Integrated Afforestation and Ecodevelopment Schemes (IAES) and the Area Oriented Fuelwood and Fodder Project Scheme, while the Planning Commission operates two programmes itself: the Hill Area Development Programme and the Western Ghats Development Programme.

State governments implement many programmes for watershed development and soil conservation. There are a number of externally aided projects assisted by the World Bank, EEC, KfW, DANIDA, SDC and ODA. Nearly 300 NGOs are engaged in environmental work, including watershed development. Funds are also provided by the National Bank for Agriculture and Rural Development, commercial banks and cooperative societies for developing watersheds.

National Watershed Development Project for Rainfed Areas (NWDPRA)

The National Watershed Development Project for Rainfed Areas (NWDPRA) was launched during the Eighth Plan (1992-1997) in 25 states and two Union Territories and continued to be implemented during the Ninth Plan (1997-2002). During the Ninth Plan, it is proposed to treat an area of 2.30 million ha. The broad development objectives are (i) enhancement of agricultural productivity in a sustainable manner, (ii) restoration of ecological balance in the degraded and fragile rainfed ecosystems by greening these areas through appropriate mix of trees, shrubs and grasses, (iii) reduction in regional disparity between irrigated and rainfed areas and (iv) creation of sustained employment opportunities for the rural poor. Impact evaluation studies both on the ground and through remote sensing techniques have shown that watershed based interventions have led to increases in groundwater recharge, increase in number of wells and water bodies, enhancement of cropping intensity, changes in cropping pattern, higher yields of crops and reduction in soil losses.

Agro-economic research centres in the ministry of agriculture and other agencies in each state where the project is being implemented did detailed impact evaluation studies. They revealed that the project substantially helped increase productivity and provided additional employment to the local people (Compendium).

Soil Conservation in Catchments of River Valley Project (RVP)

Soil conservation in this programme commenced in 1961/1962 during the Third Five-Year Plan. The target catchment area is 71.2 million ha and total treatable area is 17.7 million ha implemented in Andhra Pradesh, Assam, Bihar, Gujarat, H.P., Jammu and Kashmir, Karnataka, Kerala, Maharashtra, Punjab, Orissa, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal. The main project objectives are: (i) enhancement of productivity of degraded land; (ii) prevention of soil loss from catchment areas (iii) improvement of land capability and moisture regime; (iv) creation of awareness for catchment core; and (v) optimization of resources for socio-economic upliftment.

Soil Conservation in Catchments of Flood-prone Rivers (FPR)

Beginning in the Sixth Five-Year Plan (1980-1985), the total extent of catchment area covered is 20.0 million ha and the treatable area is 7.4 million ha. The scheme is being implemented in Bihar, Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Rajasthan, Uttar Pradesh and West Bengal. Its main objectives are (i) reduction of runoff from the catchment to reduce peak flow, (ii) prevention of soil loss from watersheds, (iii) improving land capability and moisture regimes, (iv) creation of awareness for catchment cores and (v) optimization of resources for socio-economic upliftment.

Reclamation of Alkali Soils

Beginning in 1985-1986, this programme has been implemented in Gujarat, Rajasthan, Madhya Pradesh, Haryana, Punjab and Uttar Pradesh where there are alkali soils estimated at 3.6 million ha. Its objectives are to (i) reclaim alkali lands for increasing crop production, (ii) improve land productivity, (iii) raise horticulture production, (iv) increase production of fuelwood and fodder species and (v) to generate employment opportunities in rural areas.

Alkali Land Reclamation and Development with EEC assistance

Commencing in 1993-1994, ALRD is being implemented in Bihar and Uttar Pradesh to improve the incomes of disadvantaged and marginal farmers by reclaiming potentially fertile alkali land.

Watershed Development Shifting Cultivation Areas (WDPSCA)

From 1994-1995 WDPSCA began work in a 2.3-million ha area in nine states of which the northeastern states account for 2.0 million ha. The scheme is implemented in Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Its objectives are to: (i) protect the hill slopes of *jhum* areas and to reduce further land degradation, (ii) settle *jhumia* families by providing developed productive land and improved cultivation packages, (iii) improve the socio-economic status of ethnic minority (tribal) families and (iv) reduce the *jhum* cycle for mitigation of the ill effects of shifting cultivation and to preserve the eco-environment.

Integrated Wastelands Development Programme (IWDP)

Under implementation since 1989-1990, this scheme seeks to develop non-forest wastelands through the holistic development of watersheds. It aims at checking land degradation, putting wastelands to sustainable use and increasing bio-mass availability – especially fuel wood and fodder. The scheme strives to increase rural employment and to ensure people's participation in wastelands development at all stages. Major activities include soil and moisture conservation measures, plantation, agro-forestry, horticulture, training and awareness campaigns.

Drought Prone Area Programme (DPAP)

A large scale government initiative, the Drought Prone Areas Programme (DPAP) was launched in 1973-1974 to deal with the special problems faced by fragile areas continuously affected by severe drought. The responsibility of planning, executing and maintaining their watershed projects is entrusted to local peoples' organizations formed for the purpose.

The basic objective of the programme is to minimise the adverse effects of drought on crop and livestock production, land productivity, water and human resources thereby ultimately leading to the drought proofing of the affected areas. The programme also promotes overall economic development and socio-economic improvement of the resource poor and disadvantaged in the programme areas. Some 961 blocks of 180 districts in 16 states are covered: Andhra Pradesh, Bihar, Chhatisgarh, Gujarat, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnatake, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, Rajasthan, Uttar Pradesh, Uttaranchal and West Bengal where 11 738 watershed projects in an area of 5.9 million ha have been targeted for development in the next 4-to-5 years at a cost of Rs. 23.48 billion (US$500 million) with an average project size of 500 ha.

Desert Development Programme (DDP)

As recommended by the National Commission on Agriculture (1976), the Desert Development Programme (DDP) began in 1977-1978 in both hot desert areas of Rajasthan, Gujarat and Haryana and the cold deserts of Jammu and Kashmir, and Himachal Pradesh. Since 1995-1996, coverage has been extended to few additional districts in Andhra Pradesh and Karnataka. The programme focuses on mitigation of the adverse effects of desertification and adverse climatic conditions on crops, human and livestock populations, and combating desertification. The programme also aims at restoring ecological balance by harnessing, conserving and developing natural resources, i.e. land, water, vegetative cover and raising land productivity.

Since its inception until 1994-1995, over 550 000 ha were treated under the core sectors of land development, water resource development and afforestation/pasture development. Presently, 232 blocks of 40 districts in seven states are covered: Andhra Pradesh, Haryana, Gujarat, Himachal Pradesh, Jammu and Kashmir, Karnataka and Rajasthan. Currently DDP has targeted 5 353 watershed development projects over a 4 to 5 year period.

Integrated afforestation and ecodevelopment projects

State forest departments, autonomous bodies, research institutes and universities implement projects. The main objectives of the scheme are the (i) regeneration and ecodevelopment of degraded forests and adjoining areas on a watershed basis, (ii) augmentation of availability of fuelwood and fodder and (iii) employment generation for the most needy sections of society. About 227 000 ha were planned to be covered in the Ninth Plan.

Area oriented fuelwood and fodder project scheme

This scheme (i) augments production of fuelwood and fodder through regeneration of degraded forests and adjoining lands, (ii) promotes practices for efficient use of fuelwood and (iii) encourages people's participation in planning, implementation and management of projects. An area of 341 000 ha is to be covered in the Ninth Plan (1997-2002).

Hill Area Development Programme and Western Ghats Development Programmes

These programmes started in the Fifth Plan with a focus on watershed development and are being implemented in designated hill districts of Assam, West Bengal, Uttar Pradesh and Tamil Nadu.

MANAGEMENT OF LAND AND WATER DEVELOPMENT PROJECTS

The government manages major and medium irrigation projects. Individual farmers maintain most minor irrigation facilities. Regarding watersheds, there is provision for the establishment of watershed associations comprising all adult members residing within the watershed area. If a project area covers only one village, the Gram Sabha (local council) will be designated as the watershed association. A watershed committee of 10 to 12 members representing various sections of society (nominated by the association) is primarily responsible for carrying out projects. In addition, there is a full time secretary, preferably a local graduate (from the same village or a nearby village) who is assisted by local volunteers to implement the watershed development project at the village level.

Another mode of developing and maintaining watersheds is to set up a Friendly Farmers Forum by village consensus to conduct the work of training farmers, reviewing watershed development progress and helping form self-help groups. NGOs are involved in training self-help groups and in watershed maintenance.

Watershed development programmes undertaken thus far have mixed story of success and failure. It is understood that these projects cannot succeed without full participation of project beneficiaries and careful attention to issues of social organization. This is because success depends on consensus among a large number of users. Moreover, collective capability is required for management of commons and for new structures created during the project.

BENEFITS OF INVESTMENT IN LAND AND WATER

The primary purpose of investment in land and water is to increase production and productivity. Employment generation with a view to providing livelihood to the rural people and maintenance of ecological balance are the other benefits expected of these investments. Studies undertaken to assess the impact of implementing major, medium and minor irrigation projects have shown increased employment potential and income generation in the command areas. In the case of watershed management and soil conservation, studies have also revealed a significant increase in land productivity, employment generation and improvement in the living conditions of local population. Budgets for these projects are mainly wage payments to local people engaged in construction and development work. The resultant structures are additions to capital formation in the economy. Other ecological benefits such as biomass creation and groundwater recharge follow as a consequence of watershed creation.

The Ministry of Agriculture assessed the impact of irrigation on increasing foodgrains production. It found that a 1 percent increase in the irrigated area would increase production by 4

million tonnes (if the area and production technology continued as before and fertilizer use increases at the same rate as in the recent past). The study shows that a major contribution to increase in production is attributable to expansion of irrigation facility. Therefore, continued efforts in the past to increase irrigation facilities in conjunction with technological improvements and increased input use have increased the agricultural GVA from Rs.811 billion (US$17.26 billion) in 1950-51 to Rs.2903 billion (US$61.76 billion) in 1990-2000. Foodgrain production increased from 51 million tonnes to 209 million tonnes during the same period and a major part of increase in it can be attributed to increase in area under irrigation. The corresponding increase in per capita availability of foodgrains was from 395 grams per day to 470 grams per day (Table 4).

TABLE 4
Increase in agricultural production and work force

Year	GVA (Rs. billion)	GVA (US$ billion)	Foodgrain production (million tonnes)	Per capita foodgrain availability (grams/day	Agricultural workers (million)
1950-51	811	17.3	51	395	97
1960-61	1 093	23.3	82	469	131
1970-71	1 373	29.2	108	455	126
1980-81	1 593	33.9	130	410	148
1990-91	2 231	47.5	176	473	185
1999-00	2 903	61.8	209	470	Not Available

The poverty line is defined as the level of expenditure below which it is not possible for a person to meet basic energy requirements and other needs. India's Planning Commission began identifying the poverty line and numbers of people below it in 1973-74, based on the results of National Sample Surveys on consumer spending. These measures show that the percentage of people below the poverty line has declined from 55 percent in 1973-74 to 26 percent in 1990-2000 (Box II, Table 5).

IMPACT OF POLICY ON INVESTMENT TREND AND PERSPECTIVE PLAN

(US$4.55 billion) in 1999-2000 (Table 2) its share in the total GCF has declined due to slower growth of investment in other sectors. The National Agriculture Policy adopted in 2000 (National Agricultural Policy, 2001), recognizes the inadequacy of agricultural investment. The policy proposes to create a climate conducive for increasing private sector investment in agriculture. Rural electrification, development of marketing infrastructure, expenditure-low irrigation systems, fuller utilization India inherited a stagnant agriculture at the time of independence in 1947. The first task of the Indian Government in the immediate post-independence period was, therefore, to initiate growth in agriculture. A planning framework governed agricultural policy. The quantum of the Plan outlay, its financing and the targets set for the agricultural sector were all decided through the planning process at State and Central levels. The first three five-year Plans concentrated on growth with some institutional changes including abolition of intermediaries in agriculture like Zamindars and Jagirdars. In the mid-1960s, a new technology in the form of high yielding varieties (HYVs) was introduced for cereals. Apart from the new technology, public investment in agriculture particularly in irrigation rose significantly. The public sector played an important role in the emergence of agricultural research and education. Large investments were made for the development of research system under the aegis of the Indian Council of Agricultural Research (ICAR) and the State Agricultural Universities (SAUs). Simultaneously, a well-designed extension network was created for disseminating new technologies to farmers. The administered price policy has provided incentives to

Box 2

What is the Poverty Line?

A poverty line divides the poor from the non-poor. It is often required to capture the level of essentials such as food, clothing, shelter, transport and health care. A Planning Commission Task Force in 1977 defined the poverty line as a per capita consumption expenditure level which meets average daily calorie requirement of 2 400 kcal in rural areas and 2 100 kcal in urban areas, and a non-food expenditure minimum. The monetary equivalent of this caloric intake was determined using data on food item consumption and expenditure from NSS 28th Round (1973-1974). Using a monetary equivalent for 1973-1974, implicit price indices were used to extrapolate the values for the current year. Subsequent NSS survey results were used to indicate the percentage of population below the poverty line.

In the revised procedure, monetary equivalents are obtained for individual states for the base year and applied for subsequent years by using state specific Consumer Price Indices for Rural Labourers. The state specific results of NSS on income distribution are then used to identify the population below the poverty line.

the farmers. Successive Five-Year Plans aimed at improving infrastructure through irrigation, stepping up the use of fertilizers, improved varieties of seeds, implements and machinery and supply of credit. All these measures encouraged and induced the farmers to increase investment in land and water, and consequently the private investment in agriculture started moving upwards at a faster pace.

Though Gross Capital Formation in agriculture increased from Rs. 49 billion (US$1.04 billion) in 1955-1956 to Rs. 214 billion of the irrigation potential, and setting up of agro-processing units in the producing areas are specified in the policy. Further, the National Water Policy adopted in 1987 emphasises among other things, the importance of watershed management.

Growth with equity and sustainability is the basic principle underlying National Agriculture Policy as well as the approach to the Tenth Five-Year Plan beginning in 2002-2003. Reducing the poverty ratio by 5 percent and providing gainful employment to the added labour force by the end of the plan period are included in the targets. It is intended to increase production by increasing investments in agriculture sector. Diversification of agriculture, increasing cropping intensity, rain water harvesting, development of watersheds and development of rural infrastructure such as roads and electrification are important elements of the approach to Tenth Five-Year Plan.

A perspective plan indicating targets in respect of major, medium and minor irrigation projects and required expenditure is not yet finalized. However, in respect of watershed development, the committee on the Perspective Plan for Development of Rainfed Areas has fixed the following targets for 20 years covering arable and non-arable lands, considering the requirements of varied agro-economic zones.

To increase agricultural production at more than 4 percent per annum as envisaged in the National Agricultural Policy, total investment in agriculture must also increase at the same rate under the assumption that incremental capital-output ratio remains constant in the future.

COMPLEMENTARITY BETWEEN PUBLIC AND PRIVATE INVESTMENT

Public sector investment in agriculture is directly or indirectly expected to increase private sector investment. In India it has been observed that public investment was higher than private investment until 1980, but its share began to decline in subsequent years. However, private sector investment has been increasing continuously. This may raise doubt regarding the positive relationship between the two sectors. However, a closer look would reveal that the phenomenon is due to the time lag between public investment and the induced private investment. There is a strong correlation between public and private investment if we take the delayed effect into consideration. Further, public investment in electrification and rural infrastructure (not included in agriculture GCF) also influences private investment. The National Agriculture Policy and the approach to the Tenth Plan have rightly emphasized increasing public investment in irrigation and land development along with the development of rural infrastructure.

TABLE 5
Number of Indians below poverty line

Year	Rural		Urban		Combined	
	Millions of persons	Population below poverty line (%)	Millions of persons	Population below poverty line (%)	Millions of persons	Population below poverty line (%)
1973-74	261	56	60	49	321	55
1977-78	264	53	65	45	329	51
1983	252	46	71	41	323	44
1987-88	232	39	75	38	307	39
1993-94	244	37	76	32	320	36
1999-00	193	27	67	24	260	26

TABLE 6
Costs associated with five-year Plan periods

Five-Year Plan Period	Area (million ha)	Total cost (1994-1995 prices)	
		(Rs. billion)	(US$ million)
Tenth Plan (2002-2007)	15	45.0	957
Eleventh Plan (2007-2012)	15	42.0	894
Twelfth Plan (2012-2017)	15	39.0	830
Thirteenth Plan (2017-2022)	15	37.5	798

CONCLUSION

Land development and irrigation have been given high priority in India's various Five-Year plans. Areas under cultivation and irrigation have increased significantly. Foodgrain productivity increased due to irrigation and the introduction of high yield varieties. Per capita foodgrain availability increased from 395 grams per day in 1950 to 470 grams per day in 1999. Incomes also increased, enabling people to fulfil their calorie requirements of food. This resulted in reducing the percentage of persons below the poverty line from 55 percent in 1973-1974 to 26 percent in 1999-2000. However, it is necessary to step up investment in land and water to increase production substantially, ensure food security in the wake of population increase and make agriculture a viable occupation in the global economy.

DRAFT STATEMENT ON INVESTMENT IN LAND AND WATER

India continues to be a predominantly agricultural economy with almost two-thirds of its population depending on agriculture for livelihood. The growth of agriculture in recent decades – particularly foodgrains production – has been spectacular. India has not only become self sufficient in foodgrains but has begun to produce exportable surpluses. Development policies and schemes have led to rising income levels of the population and the incidence of poverty has reduced substantially. Growth in the

agricultural sector has been possible because of such policies as significant public investment in land and irrigation facility development, emphasis on research and development, and new technologies.

Indian agriculture is only 40 percent under irrigation and remains heavily dependent on monsoon rainfall. A significant proportion of land is degraded requiring substantial investment for its improvement. Overall agricultural productivity is still far below its potential. About 80 percent of all farmers belonging to small farmer and marginal categories and have limited capacity themselves to invest in improving productivity.

Public investment in agriculture has declined. It is recognized that the decline must be halted and investment stimulated, particularly in irrigation and land development for the diversification of agriculture, improving cropping patterns and increasing productivity for food security. The green revolution must be extended to rainfed areas.

India recently prepared a long term National Agricultural Policy to achieve an annual agricultural growth rate of 4 percent by using the untapped potential of Indian agriculture for food and nutritional security and strengthening rural infrastructure to support faster agricultural development. This would accelerate the growth of agribusiness, create employment in rural areas, secure a fair standard of living for farmers and agricultural workers, help eliminate poverty and discourage migration to urban areas. It would also help the agriculture sector face challenges arising from economic liberalization and the adverse affects of globalization.

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LAND AND WATER RESOURCES DEVELOPMENT IN INDONESIA

BACKGROUND

The agriculture sector in Indonesia is considered by government to be strategic and is a main core of the national development programme. Some arguments for this consideration are as follows:

- land and water resources are abundantly available as basic resources to develop more productive agricultural activities;
- agriculture plays an important role as a main pillar to sustain and to provide staple food for the people of Indonesia;
- most Indonesians are engaged in agriculture;
- Indonesia's agriculture mainly uses domestic materials and fewer imported raw materials;
- Indonesia's agriculture has great potential to produce high value commodities for export to increase national foreign exchange earnings; and
- agriculture in Indonesia demonstrated its survivability and was a driving force to turn the 'wheel' of the grassroots economy when the monetary and economic crisis hit the country in 1997..

Indonesia's 1945 National Constitution stipulates that “Land and water and all natural resources underneath are under the control of the government and [are to be] exploited as much as possible for the prosperity of the whole nation." (Article 33)

The statement “under the control” does not mean physically authorized by the government. Rather that all exploitation of natural resources by any individual or group in the community, including land and water having economic value and social function, will be controlled by the government. Exploitation is undertaken on a sustainable basis and for the maximum prosperity of all Indonesian people.

The agricultural development paradigm took on a new life during Indonesia's recent era of reformation, with a significant transition to cope with the new needs. The paradigm centres in three basic principles: (i) agricultural development should reflect democracy, transparency, accountability, good governance and decentralization; (ii) agricultural development should put first priority on community-based participation, e.g. the role of government is restricted to that of being a regulator, facilitator, catalyst and dynamic force; and that (iii) agricultural development is carried out in accordance with the right or authority as stipulated in District/Regional Autonomous Law No. 22, 1999 including its implementation regulation (Government Regulation No. 25, 2000).

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POTENTIAL OF LAND AND WATER RESOURCES

Land resources

Indonesia's total land area is approximately 192 million ha (Puslitanak, 1992). Although the country has an extremely large land resources potential for agricultural development, in fact significant challenges must be faced.

According to the National Statistical Bureau (1998), total agricultural land use in Indonesia – paddy fields, household gardens and orchards, rainfed uplands and drylands, open grass, brackish and freshwater fishponds, swamps, state and private plantations – is about 66 million ha.

Paddy rice accounts for about 11 million ha of Indonesia's total area (Ministry of Public Works, 1998). Depending on the source of water and the provision of irrigation facilities, land is classified as technical irrigation areas (3.4 million ha or 31 percent), semi-technical irrigation areas (1.12 million ha or 10 percent), simple irrigation areas (0.77 million ha or 7 percent), village irrigation areas (2.29 million ha or 21 percent), inland and tidal swamp (1.677 million ha or 15 percent) and rainfed areas (1.77 million ha or 16 percent).

In addition to paddy rice areas, Indonesia also has vast dryland and non-irrigated areas. The total area of dry land in Indonesia is about 57 million ha and is commonly used for such purposes as household yards, rainfed agriculture, upland/plantation and open grassland, while the remainder is neglected as dormant or 'sleeping' land.

WATER RESOURCES

Water is a central input for agricultural production. Potential water resources include rainwater, groundwater and surface water.

The amount of water in Indonesia fluctuates by season and is distributed differently among the regions. In general, most Indonesian regions have an annual rainfall of about 2 000-3 500 mm (60 percent). Some areas (3 percent) have annual rainfall over 5 000 mm and others having rainfall of less than 1 000 mm annually. This data indicates that Indonesia with its humid tropical climate gets uncountable natural abundance in the form of high rainfall, though in certain areas occasional water shortages or drought takes place.

Indonesia has a total territory of 1.9 million km^2 and has an average annual rainfall of 2 700 mm. Of this, only an average of 278 mm (10 percent) infiltrates and percolates as groundwater. The remaining (larger) portion flows as runoff or surface water (1 832 mm). If this water – groundwater and surface water – can be managed properly, it would be readily available with a total amount of about 2 100 mm annually or equal to the discharge of irrigation water of about 127 775 m^3/sec.

Total water storage capacity in terms of area in Indonesia is about 13.75 million ha – consisting of lake storage (1.777 million ha or 13 percent), dam and reservoir storage (50 000 ha or 0.4 percent), rivers (2.895 million ha or 21 percent) and inland swamp/polder (9 million ha or 65 percent).

FACING PROBLEMS OF LAND AND WATER RESOURCES DEVELOPMENT

Land resources

To utilize land resources optimally for more productive agriculture, Indonesia must face some crucial problems. Those problems are determined in six different categories:

Transformation of productive agricultural areas into critical land. Critical land formation takes place as a result of mismanagement of productive agricultural areas by ignoring soil and water conservation in farming practices.

Critical agricultural areas in Indonesia have reached approximately 8 million ha (Ministry of Forestry, 1997), consisting of potential critical land of 4.712 million ha (50 percent), semi critical land of 1.893 million ha, critical land of 1.247 million ha (16 percent) and an extremely critical land area of 224 000 ha. The growing impact of agricultural land degradation is seen in the increasing decline of land productivity, reduced hydrological function, and increasing sedimentation that gradually can cause the shallowing process of dams, rivers and irrigation canals.

Marginal land. Generally speaking marginal land is less productive, whether dry- or wetland, due to its formation process and its nature and properties. In Indonesia, marginal wetland is found in swampy peaty land and acid sulfic soils under tidal swamp ecosystems with a total area of about 24 million ha, while marginal dry land is easily obtained in acidic red or yellow podzolic and oxisol soils (about 47.5 and 18 million ha respectively).

Sleeping land. 'Sleeping land' is temporarily uncultivated or neglected land that does not match its previously allocated land use planning classification such as for agriculture, housing, industry and public services. According to the National Land Agency (1988), the total amount of sleeping land in Indonesia is about 1 132 000 ha consisting of uncultivated agricultural land of 1 026 000 ha (55 percent), housing area of 24 000 ha (14 percent), industrial area of 15 000 ha (8 percent), service and others of 9 500 ha (6 percent). The presence of sleeping land is mainly due to factors such as a shortage of labour during land preparation, careless landowners who work in off-farm sectors, distant residence of the landowner, low land productivity and failures of harvest due to pest outbreaks and floods.

Conversion of paddy rice land The rapid process of development has implications for the increasing unavoidable demand for appropriate land. Paddy rice areas are not exceptions. The conversion function of land from agriculture (in this case paddy rice) to non-agricultural land undoubtedly brings about a significant loss to the country, e.g. reducing fertile land, idle use of high cost investment in irrigation infrastructure, the disappearance of rural job opportunities for landless farmers, declining food crop production, and a threatened national food security system.

Ministry of Agriculture data indicates that from 1981 to 1985 and from 1998 to 1999 the conversion of paddy rice land to non-paddy or non-agricultural land affected approximately 246 000 ha. Those conversions are, consecutively, to resettlement (housing): 30 percent, industry: 7 percent, dry land: 20 percent, plantation: 25 percent, fish ponds: 3 percent and others 15 percent. During the five years noted above it clearly deminstrates that the conversion rate is almost 50 000 ha annually. Unfortunately, the majority of rice field conversions (90 percent) takes place in Java (West Java, Yogyakarta and East Java provinces) which account for 60 percent of national rice production. To compensate for the loss of fertile land in Java by developing new land elsewhere (on other islands) outside Java is not easy. In addition to the budgetary burden, most land outside Java is not as productive as that in Java.

Land fragmentation One reasons why agricultural practices in Indonesia are becoming more marginal and difficult to improve efficiency of farming practices is the tendency toward land fragmentation. This fragmentation has caused landholding averages to decrease to only 0.3 ha per household in Java and 0.5 ha per household outside Java.

Land fragmentation tends to occur because of traditional community inheritance systems and is closely related to existing socio-cultural and customary norms or communal values. If the tendency continues, average landholdings will become too small, eventually making them more susceptible to conversion to non-agricultural purposes.

Infrastructure development of optimal irrigated area According to the Ministry of Public Works (1988) it is reported that Indonesia has:

- some 204 000 ha of paddy rice with undeveloped or insufficient primary (main) irrigation systems, on-farm canals or other irrigation infrastructure and facilities;
- about 366 000 ha of existing paddy fields are served by completed main system irrigation facilities, but are without on-farm (distribution) facilities;
- available land of 287 000 ha has main system facilities built but the land has not been converted to rice field due to the absence of on-farm irrigation facilities;
- about 13 million ha of village irrigation command areas have not been rehabilitated and furnished with on-farm level irrigation facilities;
- approximately 1.39 million ha of swampy areas have been developed to paddy rice field equipped with main canals but having no on-farm or micro irrigation systems;
- some 1.8 million ha of rainfed paddy field have no available irrigation infrastructure; and
- some 1.291 million ha of dry land and upland has potential to be developed into paddy rice fields, but irrigation infrastructure and facilities, both main and on-farm, have not been constructed.

From this it can be seen that there is about 6.3 million ha of unproductive agricultural areas because of the unavailability of irrigation infrastructure and facilities.

Water resources

Even though Indonesia is a humid tropical country with high annual average rainfall, its problems of water resources are still prominent. Some of main problems are:

Rising water demand. There is a strong community demand for water that satisfies the public in terms of quantity – and quality tends to increase. Conversely, because the quantity of available water is relatively constant, competition among sectors such as agriculture, domestic, municipalities and industry for limited water is becoming more intense. Therefore, a policy that wisely arranges the use and distribution of water is indispensable.

Lack of upland/upstream land management. Land management in the upper catchments without consideration to soil and water conservation tends to create critical lands, causing devastating floods and drought in the lower areas. Indonesia at present has approximately 8 million ha of critical agricultural land.

Erosion-related degradation. Water functions such as lakes, rivers, or dams as well as irrigation canals tends to decrease along with an increasing rate of soil erosion creating siltation and shallowing processes.

Population growth. Water pollution tends to increase with population increase and sectoral development that produces pollutant or byproducts.

Inefficient irrigation water management due to irrigation facility damages and inappropriate irrigation water application at on-farm levels can cause uneconomic or over-use of irrigation water.

Extreme climatic change can give rise to flood and drought disaster. Such disasters are often caused by abnormal global climatic changes such as El Nino or La Nina. Long drought periods destroying hundreds of thousands of hectares of paddy rice field occurred in 1991, 1994 and 1997.

Over-pumping of groundwater without considering discharge capacity has created intrusion of sea water and groundwater pollution.

Weak water user associations have reduced the effectiveness of irrigation water management at the on-farm level. To illustrate, it is reported that of 39 000 existing or newly-created water user associations, only 11 000 units (28 percent) were in fact developed enough to function properly.

POLICY ON LAND AND WATER RESOURCES DEVELOPMENT

We have described that the potential of land and water resources is quite available, but in reality there are many complex problems still to face to develop more productive use of land and water resources.

Indonesia's Ministry of Agriculture has determined a vision to cope with the recent national agriculture development policy, e.g. to establish agribusiness systems with competitive power and which are "people oriented, sustainable and decentralized". This vision must be manifested operationally in viable policies to make the agricultural sector become the core of all sectors of national development.

To enforce the establishment and accomplishment of this vision, strong support from land and water resources development are strategically critical and determine success or failure. Based on these circumstances, the Indonesian government launched a set of general and specific policies on land and water resources development. Evaluating the effectiveness of these policies is continuous, to improve their substance and content depending on actual situations and conditions.

Policy on land resources development

Critical land The policy to prevent the growing increase of critical (degraded) land in Indonesia is to introduce and to develop upland farming conservation practices to farmers. This farming practice emphasizes the maximum use of land throughout the year by considering soil conservation norms and applying soil conservation techniques to improve soil productivity, sustainability and farmer income. This policy is basically taken to recover, maintain and increase the hydrological function, increase agricultural production and improve farmer income on a sustainable basis. This policy and future actions will be continued and improved since its impact is positive and it has multiplier effects.

Marginal land Government policy aims to manage marginal land and carry out land improvement and amelioration to increase land productivity both in uplands and wetland. This policy implemented through some programmes has a certain target – technology transfer and know-how to farmer through intensive extension and training. It is strongly expected that farmers be able to apply the technology by themselves. In future this policy will be developed and improved so that farmers can effectively manage marginal land.

Sleeping land Increasing areas of sleeping land in Indonesia cannot be separated from three factors: the limited (low) availability of labour, land or agrarian law and soil productivity. Therefore, the

problem solving approach taken is *first* to carry out a transmigration programme either for local or general participants, *second* to develop mechanized agriculture as a comcerpt by using farm equipment and machinery. This policy will be carried out in future by giving strong notice and emphasis on law enforcement (land reform laws) particularly regarding abandoned land. Despite this concern to not let land lie unused, it is necessary for Indonesia to develop an agro-estate approach, that is to develop new land for cultivattion with high economic value crops, owned by commercial companies employing local farmers. In addition to giving guidance and direction, the role of government is to provide credit at appropriate (reasonable) interest. If the potential of 'awakening' sleeping land in Indonesia can be developed effectively, undoubtably the agricultural sector will grow quickly and create new job opportunities.

Conversion of land function The occurrence of land conversion implies fast development in various other sectors requiring land. Nevertheless, if the land required is agriculturally fertile every such conversion will threaten the sustainability of Indonesia's agricultural sector and farming practices. Therefore prevention of land conversion must be seriously considered.

Current government policy to compensate for the loss of fertile land is to develop new agricultural land/riceland outside Java. This effort appears to be minimally effective as the rate of new lands being opened does not keep pace with land which is lost. In addition, the availability of labour outside Java is so limited that land utilization not optimal. Another limiting factor is that developing new agricultural land is quite costly. In considering these constraints, it becomes clear that in future the policy can be improved by developing new agricultural land/rice fields more selectively, and that both newly-irrigated areas and swampland can become productive. In spite of this hopeful policy, a more strict law enforcement policy on land use planning will be adopted.

Land fragmentation Land fragmentation means that with holdings growing progressively smaller and smaller, farming tends to become inefficient in scale. A recent policy step is to consistently apply laws or regulations for not further fragmenting small parcels. Community and government intervention is required. Another approach to counter land fragmentation is to introduce land consolidation through “corporate farming” in which farmers with small farms can join with others to make larger plots and so become more efficient, but without changing their landownership rights.

Staged infrastructure development toward irrigated land. Agricultural land that has not been cultivated optimally due to the absence of irrigation infrastructure will be developed through programmes and projects step by step. Such programmes include new construction and rehabilitation of irrigation networks not only their main system but also on farm level. For upland and rainfed agriculture, pumps, ponds and storage will be introduced.

Water resources development policy

To resolve problems water resources development, Indonesia has taken the following policy initiatives:

To conserve water including preventing water losses and improving the water holding capacity of soil. This is to maximize infiltration and percolation of rainwater into the ground and to minimize loss of rainwater as surface runoff. Percolated rainwater can be stored as groundwater and surface water can be stored in dams or other water storage. Future policy will be directed to increase the number of small-scale dams and ponds to serve as water reservoirs to supply irrigation water during the dry season.

To encourage a national water saving movement with all members of the community as water users. The movement aims to avoid wasteful use of water in all phases of distribution or conveyance.

Therefore, the water saving movement is principally an effort to change the attitudes, habits or customs of all levels of the community as well as government employees in order to use water more efficiently. It is not easy to change a certain communal or social habit, therefore the success of the water saving movement will take time. Implementation of this policy will be continuous and consistent to allow attitudes to change.

To carry out reforestation and regreening in upper catchments and to implement soil conservation farming in slope areas.

To improve the operation and maintenance (O&M) of all irrigation infrastructure for optimal functioning. In implementing O&M, the active involvement of farmer or water users' associations is maximally encouraged in order to create a sense of belonging among all users of irrigation infrastructure and facilities that have been built.

To prevent water resources pollution from domestic and industrial waste. Future policy will be law enforcement in the form of a measure to all activities against law and regulation that tends to create pollution problems to the environment/water resources. Dangerous and toxic pollutants from industrial waste must be treated and protected with strong laws or regulations.

To increase the efficient use of irrigation water, efficient water use technology and management should be implemented and developed. Technology that farmers might adopt includes pressurized irrigation (either sprinkler or drip irrigation). In addition, increased water efficiency at the rice plot level of continuous flooding or submersion must be changed to intermittent methods. By applying these techniques crop productivity is not smaller than when continuous flooding is used despite less water being used.

To anticipate climatic changes particularly global climatic abnormalities creating long drought periods (El Nino) and high rainfall or flooding (La Nina), The Early Warning System is being introduced to develop actions and prevention efforts in anticipation of an unexpected disaster so that losses and damage can be minimized. Anticipation approaches include strategic, tactic and operational approach.

To prevent groundwater pollution and seawater intrusion, groundwater pumping must be done carefully in consideration of the recharge capacity. Supervisory systems should be established for implementation by authorized government institutions at provincial, district or municipal level.

To improve the performance of water user associations in managing irrigation water, the efforts taken must empower water users' associations in such ways that eventually autonomous, socio-culturally rooted, and environmentally, oriented are established.

INVESTMENT IN AGRICULTURE AND ITS CONTRIBUTION TO NATIONAL FOOD SECURITY

Since the first five-year development plan (PELITA), positive growth of the agriculture sector has been a focus of attention in the overall development of Indonesia. The government vigorously acted to reduce food (rice) dependency from imports and the world market. In the 1960s and 1970s Indonesia was well known as a major rice importing country. At the time of former President Soeharto, it was realized that economic development was much more important than simple political euphoria when the majority of the people were poor – and some were starving.

During the first four development plans (PELITA), investment in land and water resources development mainly emphasized agricultural development, especially food crtops and rice self-

sufficiency. Thousands of hectares of paddy rice areas were developed throughout Indonesia on islands outside Java focusing as major developing area. Land and water resources development is essentially inseparable, and have been developed simultaneously. Hundreds of existing irrigation network with facilities and infrastructure not functioning well have been rehabilitated and reconstructed. Many new irrigation networks have also been constructed. In order to manage operation and maintenance irrigation facilities on farm level thousands of existing water user associations have been strengthened and new ones were established.

To ensure the sustainability of water storage capacity of irrigation works, most catchments nationwide were protected through a national regreening project. Many degradated catchment areas have been rehabilitated, reducing erosion and improving their hydrological condition.

Together with land and resource development, other agricultural development policies related to increasing food crop production have been vigorously strengthened. The main focus of policy was on increasing agricultural production through improved agricultural technology based on a selected package of improved seeds and varieties, fertilizers and pesticides. Designing and providing such improved technology packages was done through a national mass guidance programme. Adoptiing technology at the field level was facilitated by appropriate financial packages and subsidized credit channeled through village cooperative units. A large-scale agricultural extension programme using thousands of well-trained field extension workers was introduced to reach people near major-road networks.

Using such land development, irrigation, construction and rehabilitation, and crop intensification schemes, Indonesia achieved rice self-sufficiency in 1984. Government investment in the irrigation sector in fiscal year 1994/1995 reached 338.8 billion rupees or some US$300 million. Rice self sufficiency was maintained until 1993, despite temporary government measures to import some rice as a national buffer stock for market operation in case of rice scarcity – especially during the dry season.

As Indonesia gained confidence in securing its national food supply, attention gradually began to include the industrial sector. Government strategy for promoting industrial development emphasizes both export promotion and import substitution. Looking to the industrial sector as a driving force in the national economy is intended to be supported by a strong agricultural sector. Therefore since the end of the 1980s, government investment in land and water resources development as well as other use of agricultural production inputs has gradually decreased. Since the beginning of the 1990s investment in land and water resources has been mainly focused on improved operation and maintenance of irrigation infrastructure and facilities.

Due to the rapid rate of fertile agricultural land conversion to non-agricultural use reaching some 50 000 ha per year, prolonged drought and flood periods because of global climatic abnormality, environmental degradation, reduced subsidies of agro-inputs and agricultural extension activities, Indonesia's rice self sufficiency began to be unstable. Although rice self-sufficiency was achieved in 1984, rice imports gradually increased. In the 1990s the level of rice imports have grown, reaching some 6 million tonnes in 1998 – or some 20 percent of domestic consumption. Such imports joined the pre-existing monetary and economic problems and growing political instability.

To regain food self-sufficiency, Indonesia has given renewed attention to production, allocating substantial funds both from national budget and from international lenders. Starting from the 1995/1996 fiscal year investment from national budget financed a substantial land and water resource development projevc in Central Kalimantan, the so-called One Million Hectares of Tidal Swamp Development Project. This ambitious environmental project achieved worlwide notoriety by absorbing one billion rupees from the national budget to provide new land to substitute for significant and rising losses of fertile paddy ricefields in Java. However, the project yield is little compared to its

expectations. While basic land and water resource development has been attempted what remains is mostly environmental degraded land. This is Indonesia's worst lesson in what can go wrong in land and water resource development.

In addition to many small projects financed through the national budget, there are many land and water development projects financed by international donors such as the IBRD, JICA/JBIC and the ADB. Since 1990 there have been many major donor supported programmes for agriculture and rural development including land and water resources development projects, such as the IBRD-financed Groundwater Development Project, implemented in 11 provinces from 1993 to 1999; and the Integrated Swamp Development Project conducted in 1994 to 2000 in three provinces.

The Asian Development Bank-financed Upland Farming Development Project was conducted in four provinces from 1995 to 2000. It also financed programmes such as the Second Irrigation Sector Project from 1994 to 2000 and the Sulawesi Rainfed Agriculture Development Project from 1994 to 2000 in four provinces in Sulawesi. All the projects have an objective to increase productivity of land and food crop production by introducing varied techniques, inputs, practices and farm management to contribute to agricultural development, increase farmer income and alleviate poverty in rural areas.

To alleviate rural property commonly inherent with upland areas, a more attention gradually being paid to upland areas that during the last decade getting less attention than lowland/paddy rice area. The policy of focusing rice field as a target of agriculture development tends to cause that a region dominated with lowland generally become more prosperous than that of upland areas. Many villages classified as poor are situated in upland areas. Introduction of integrated upland conservation practices through the Sulawesi Rainfed Development Project exemplifies government efforts to reduce poverty, particularly in rural areas. By this integrated project, high value economic crops and other agricultural commodities such as livestock, estate crops and poultry are introduced. At the same time, rural infrastructure such as farm and village road, drinking water facilities, checkdams and other soil and water conservation structures were constructed on a communal and participatory basis to ensure sustainability of the project activities.

In fact, poverty is also present in urban and suburban areas that grew rapidly during the monetary and economic crisis. Since the rate of economic grow was very low and the exchange rate of the US dollar was so high, many private companies using imported raw materials could no longer survive. Job opportunities became very limited; many people lost their jobs. To provide job opportunities and to alleviate poverty, land (particularly 'sleeping land' around urban or suburban areas) was cultivated extensively by planting short growth period-high value economic crops. This farming practice is usually called peri-urban agriculture.

In terms of national food security, though the investment on land and water resources development is not as big as that of allocated budget in fiscal year 1994/1995, national rice production in the year 2000 has surprising surplus over 2 million tonnes. This surplus mainly resulted from improved intensification, favourable climate and weather conditions, increased cropping intensity and rice planting area and declining national per capita rice consumption (below 120 kg per year). Therefore, rice import policy questions are currently not so urgent, or if so for some reason, it would not likely be during harvest.

CONCLUSION

National food security on quantity basis meaning self sufficiency of rice remains a major concern of the government until recently. It is realized that investment on land and water resources development

has gradually decreased since the achievement of rice–self sufficiency in 1984 in accordance with the staring policy of placing industrial sector as a driving force of national economic growth. Unfortunately, the sufficiency of rice did not last longer indicated by growing import of rice since 1993.

To obtain again sufficiency of rice a strong struggle has been made by the government. Along with overcoming land and water resources problems, some national actions were taken such as increasing the quality of intensification, increasing cropping intensity, expanding planting area, improving agriculture infrastructure and facilities – including improvement of irrigation networks and improving food diversification. Eventually in 2000 and 2001 there was sufficiency of rice with a surplus of more than 2 million tonnes. However, in anticipation of the growing national food demand in the twenty-first century with an annual population increase of about 2 percent, significant budget must be invested in the agricultural sector including on land and water resources development.

LAND AND WATER INVESTMENT IN THE LAO PDR

BACKGROUND

The Lao People's Democratic Republic (Lao PDR) is a small landlocked country located in the Indochina Peninsula. It is increasingly being recognized that landlocked can be interpreted as land-linked, changing the emphasis from regional exclusion to regional inclusion. The country's total area is 236 800 km^2. About 20 percent of the land area is flatland (70-200 msl); the other 80 percent is sloping hillsides and mountains (200-2 820 msl). The Lao PDR has a tropical monsoon climate: annual rainfall averages 1 000-1 500 mm in most of the country. While there is an abundance of forest and water resources with potential for development, both floods and drought are commonly experienced. The population is about 5 million persons with a growth rate of about 2.5-2.8 percent per annum. Lao is a multi-ethnic country having some 48 ethnic groups.

From 1975 to 2000, the development of the socio-economy of the Lao PDR improved significantly. Agriculture is the main sector of the national economy and has shown marked success, especially from 1997 to 2000, in spite of the negative impact of the financial crisis of 1997 and after. Agriculture's share of GDP was about 51 percent in 2000, with an average growth rate of 4 to 5 percent annually. Nevertheless the pace of change has been quite uneven. Along the Mekong corridor, market forces now drive the agricultural economy. In the mountainous sloping lands away from the Mekong, subsistence agriculture and acute rural poverty predominate. Economic growth has had significant effect in raising urban living standards but its impact in remote rural areas was marginal.

In 1986, the Government of the Lao PDR (GOL) made a drastic policy reform, shifting from a centrally planned economy to a market oriented system by introducing the New Economic Mechanism (NEM). The reforms included price decontrol, liberalization of trade and payment systems, introduction of a two-tier banking system, freeing all but agriculture-related interest rates, initiation of civil service reforms, introduction of a legal framework to support a market economy and an extensive privatization programme. Considerable progress has been achieved in structural transformation and macro-economy that contributed to the growth of real GDP at the robust rate of 6.3 percent per annum from 1990 to 1994, and per capita income rising at a 3.2 percent rate over the same period. Growth accelerated to 8.1 percent in 1994, continuing at 7.1 percent in 1995 and an estimated 6.9 percent in 1996, led by the strong recovery of agricultural production and a continued boom in manufacturing, construction and services. In 1997 the Lao PDR joined the Association of Southeast Asian Nations (ASEAN) and the ASEAN Free Trade Area (AFTA).

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The effects of the crisis were significant, with real GDP growth in 1998 falling to 4 percent in contrast to rates of almost 7 percent in the previous two years. However, lowered GDP growth was

not very serious in comparison with other countries, because agriculture continued to perform well owing to relatively high prices of rice and other major crops. Paddy production increased by 18 percent from 1996 to 1998 because of increased irrigation by heavy investment in the National Pump Installation Management Project (NPIMP), while industrial sector GDP, particularly the textile industry, dropped by half from 1996 to 1997. The best performing industrial subsector was hydropower whose output increased by more than 60 percent in 1998, while the construction subsector showed a 18 percent fall in 1998 – obviously affected by the crisis.

AGRICULTURAL PRODUCTION AND NATIONAL FOOD SECURITY

Food security is still and will be the Lao PDR's highest priority strategy to stabilize economic development and socio-political security. The overall objective of national food security is to stabilize food production and maintain growth rates to meet domestic demand and overcome the basic problem of food distribution and circulation in difficult areas and at the same time increase average household food security.

As rice is the staple for the Lao people, its production must be stabilized at a high level. Increased paddy production is to be achieved through intensified production in the six major plains and expansion of cultivated areas for paddy in mountain valleys with adequate water. Rice production reached 2.2 million tonnes in 2000 compared to 1.4 million tonnes in 1995. This remarkable increase was mainly due to the rapid development of an irrigation system for dry season rice production since 1997.

Average production of paddy rice per capita has increased from 310 kg in 1995 to 430 kg in 2000. For the last five years the annual growth of rice production was 9.2 percent and other foodstuffs such as maize, roots and tuber crop, soybean, vegetables, eggs, poultry and meat products also increased. These annual growth rates exceeded the annual population growth rate of about 2.5 percent. However production of food and foodstuffs is still insufficient and unevenly distributed. Production is still not very stable due to frequent natural events, e.g. calamitous floods and drought, and limited agricultural infrastructure. There is also a wide variation in food production from region to region and among provinces. The main food producing areas are concentrated in the main plains along the Mekong River and account for 60 to 70 percent of food output. In the mountains where over half the population lives, food output was only some 30 to 40 percent of total output.

FOOD INSECURITY AND POVERTY

Government statistics (Lao Expenditure and Consumption, 1997/98) indicate that nearly one-third (30.6 percent) of the population can be classified as poor, below the low or food poverty line, while 39 percent are below the high poverty line. However, there are large differences in the incidence of poverty across urban and rural areas and across regions. The incidence of poverty is 43.8 percent in rural areas and 15 percent in urban areas.

Food circulation and distribution between regions is at present a great challenge to better ensure national food security. Half the provinces (nine of 18 provinces and cities) face frequent food deficit situations; most are located in mountainous regions where difficult transportation conditions (mainly in the north) obstructs food distribution.

GOVERNMENT STRATEGIES AND POLICIES

The strategies and policies of the Government of the Lao PDR toward development in the opening years of the twenty-first century are: (i) to completely exit the group of least-developed countries by the year 2020, to basically eradicate poverty by the year 2010, and to reduce poverty for half of the poor by the year 2005; (ii) to achieve these goals, the government continues to implement the New Economic Mechanism (NEM) in both economics and politics. This consists of continuing the in-depth transformation towards a market economy through state adjustment, promotion of all economic sectors and the exploitation and use of our resource potentials in an efficient and sustainable manner. Furthermore, (iii) government intends that national development will take place within the priorities of national programmes outlined in its current Socio-economic Development Plan: food production; stabilization and reduction of shifting cultivation; commercial production; infrastructure development; improved socio-economic management and foreign economic relations; and rural development and services development.

In this respect agriculture and forestry will play the key role in developing the national economy in the context of sustainable resource use and poverty alleviation. Most the poor are farmers in rural and mountainous areas: household food consumption in Laos strongly depends on home production. In poor rural households, food accounts for 75 percent of total household expenditure and home production contributes nearly 80 percent. Nationally, food accounts for 62 percent of total household spending, with self production contributing more than 60 percent. The poor – including both the food-poor and the undernourished – are largely rural people who depend on agriculture. Farm households have the highest incidence of poverty (52.4 percent) of all occupations. Food security issues are thus related to low farm productivity. Therefore government food security targets for the farming population are designed to increase productivity and participation in the market.

Government objectives and programmes for the agriculture sector include: (i) achieving food self-sufficiency; (ii) increasing agricultural exports through cash crop diversification and the commercialization and processing of livestock and forest products; (iii) stabilizing slash-and-burn agriculture (by land allocation for upland farmers, terracing and supporting alternative agricultural activities including agro-forestry and livestock); (iv) irrigation development programme (to increase rural incomes and stabilize food availability by expanding irrigated area in both wet and dry seasons and improving operation and maintenance); (v) agriculture and forestry research programme (to conduct study and surveys of agriculture and forest land and water researches, rehabilitate research stations; cooperate with international research institutions to develop new technology); (vi) human resources development programme (upgrade technical and political skills of staff, agricultural vocational school).

Government's sectoral strategic vision

The six programmes of the Ministry of Agriculture and Forestry (MAF) named above relate to seven themes of this sector's strategic vision, beginning with an overview of the dual economies of Lao PDR, e.g. the flat lands along the Mekong corridor and sloping lands. The thematic approaches are: MAF planning and decentralization; human resources development; business regulatory adjustment; external trade; flat land transformation; sustainable sloping land development and environmental management/shifting cultivation stabilization; and irrigation.

The planning approach: MAF planning decentralization

Policies: area-based integrated agricultural development to better respond to "focal site" rural development; fully decentralized "bottom up" participatory planning within the governmental system; indicative planning based on comparative advantage and rural socio-economic indicators; integrated area-based natural resource management centred on watersheds/river basins (at national and regional levels); local government management of funds, projects and integrated development resources; and fully decentralized "bottom-up" participatory planning with the governmental system.

Strategies: implementation through flatland and sloping land programmes to adjust for different agro-ecological concerns using area-based planning; flatland and sloping land programmes are of equal importance, planned and developed in parallel to allow for upstream and downstream linkages and interactions. Flatland priority is on maintaining the pace of market driven-growth assisted by supportive regulatory systems in parallel with consolidation food security and accelerating the pace of cash crop diversification and intensified livestock and aquaculture development for the local market and for export growth; emphasis in sloping land areas accords high priority to area-based development centred on integrated watersheds/river basins. Primary goals: to achieve stabilization of shifting cultivation and sedentarization of sloping land land-use systems with parallel emphases on supporting infrastructure, e.g. roads and tracks, small-scale irrigation and markets and service centres, followed by livestock and fisheries, forestry, annual and perennial improvement, soil fertility and water and nutrient management and natural resource management; provincial governments continue to plan and implement development in a fully integrated manner; farmer-demand driven applied research and extension; and rotational cycles of farming system.

Human resources development

Policies: MAF to become a farmer service organization in a market economy; district and District Agriculture and Forestry Office (DAFO) are primary links in MAF 'chain' because of interactions with villages/farmers; farmer demand driven adaptive research and extension, problem solving; technical support in applied research, extension and natural resource management provided by new NAFRI, AEA, at central levels; new department of planning and M&E to provide focus of integrated farming systems development.

Strategies: reorganizing DAFO staff as mobile farming systems extension workers (FSEW); reorganizing PAFS as subject matter specialists to support FSEW; transfer redundant and excess staff from flatland areas to sloping land areas; NAFRI, AEA, DOP and DME to provide central focus of integrated farming systems and natural resource management development; form a participatory applied research/extension synergy by strengthening linkages among public and private sector along the lines of successful transformation models (see Table 5).

Business regulatory adjustment

Policies: commitment to market agricultural transformation under "umbrella" of improved regulatory system as tangibly demonstrated by agricultural development progress in the Mekong corridor; support for short to medium-term regulatory revision to bring supportive regulations; and support for parallelism of business regulatory revision among partners.

Strategies: review and revise existing regulations over the short to medium term to adjust to prevailing economic environment; and review and coordinate regulatory reform measures with Lao PDR regional trading partners.

External trade

Policies: full support for trade liberalization and regional economic integration with minimal controls on export/import in concert with tangible trade liberalization measures by regional trading partners; and gradual formalizing of informal cross border flows.

Strategies: closely monitor tangible progress of regional trading partners in reducing/removing import/export permits and licenses and eliminating effective quantitative control over imports through licensing; move toward trade liberalization in concert with parallel moves by regional trading partners; operate, in concert with regional trading partners, to move many agricultural products and inputs to the AFTA inclusion list

Flatland transformation

Policies: maintain pace of Mekong corridor market-driven changes; ensure food security and accelerate the process of cash crop diversification and intensified livestock and aquaculture development for the local market and for export growth.

Strategies: development centred on rehabilitating and expanding irrigation schemes, strengthened local and community-based management of irrigation systems, improved agricultural and farming systems, increased and intensified cash crops, livestock and fisheries production. Increased investments in improving post-harvest technology and establishment of value-added small and medium processing enterprises.

More specific strategies include: increased and intensified irrigated dry season agricultural development in Mekong corridor with participatory, community management of systems; agricultural and farming systems research, with special consideration to environmentally friendly practices (e.g. IPM and organic fertilizer use); prioritizing adaptive research, trials and demonstrations; rating appropriate and more integrated technologies suitable for specific flatland environments; testing and introducing new plant/animal species; technology testing and extension of forage production and pasture systems; technology testing and extension of improved aquaculture systems; FSEW/SMS formation and training for bottom-up farmer demand-driven extension; gradual formalizing of informal trade channels in concert with liberalization of border trade with regional trading partners; streamline licensing procedures for agribusiness; continue to let market forces operate under the "umbrella" of improved regulatory system; market-determined interest and competitive environment for rural credit mechanisms; establish public sector market information channels; and set product grades and standards.

Sustainable slopeland development and environmental management/shifting cultivation stabilization

Policies: shift to an area-based and decentralized on integrated watershed/river basins; rural poverty alleviation; shifting cultivation stabilization.

Strategies: expand and strengthen government and MAF multi-sectoral approach to achieve sedentarization of slopeland agricultural communities and tenure through participatory planning; land-use zoning based on biophysical (e.g. slope and land capability) and socio-economic parameters; participatory land allocation and land-use occupancy entitlement; promotion of community management of natural resources; farming systems diversification and agro-forestry development through adaptive research, trials and demonstration on farmer's fields; expansion of community managed irrigation systems; farmer demand driven extension; sustainable land use management with soil erosion control, afforestation, and conservation management; rural savings mobilization and credit extension; rural finance development based on market determined interest rates and open

competition (generally) among private and public sector rural finance mechanisms with some specialized subsidized lending activities (specific cases) to accelerate and cushion the risks of farming systems diversification among poorest social strata; upgrade capacity and legal framework of SOCBs in commercial and banking transactions; opening community market access through feeder road upgrading and expansion and market information delivery.

Irrigation

Policies: allocation and provision of water, on a sustainable basis, for agro-forestry systems (in sloping lands) and for existing and new agricultural areas (in flatland areas); diversification of water resources for irrigation and management for sustainable utilization; improve water resource productivity, marginal values; improve maintenance of irrigation systems and strengthen O&M; maintain watersheds and mitigate environmental degradation; alleviate rural poverty; and accelerate cash crop production for exports and import substitution.

Strategies: continue to focus investment on most economical viable schemes, consolidate and expand irrigated areas; continue to strengthen community participation and initiative in project planning work and maintenance; encourage beneficiary financing in development and O&M of irrigation systems; strengthen farmer driven extension focus on cash crops, marketing and improving market access; target irrigation development on reservoir and systems; transfer ownership and management of schemes to beneficiaries through local WUAs. Empower water user associations at scheme level to set and collect irrigation O&M Irrigation Service Fees (ISF) commensurate with actual individual scheme characteristics, real scheme O&M costs and with beneficiary capacity to pay based on their gross margins from farming operations.

Master plan for integrated agricultural development

Master plan objectives are to formulate an action plan and an implementation programme that contributes to more effective agricultural development promotion, based on the Strategic Vision framework as the Lao PDR agricultural development strategy and Vision 2020 as basic development policy; and identify priority programmes and projects.

"Towards the Year 2020", an integrated agricultural development action plan, aims at ten subsectors: land and water resource development; institution and organization; human resource development; field crop; livestock and fisheries; stabilizing shifting cultivation; marketing and agroprocessing; rural finance; rural development; and irrigation.

LAND RESOURCE DEVELOPMENT

Land area and resources

The Lao PDR covers an area of 23.68 million ha of which forests occupy 45 to 47 percent, potential forests and other wooded areas (including recovering shifting cultivation areas of about 2 million ha): 41 percent, permanent and temporary arable agriculture, 8 percent, grass and pasture land 4 percent and the remaining areas 2 percent. Comparative estimated land use in three time periods is given in Table 1.

Land suitability

There is considerable information on the soils and land condition. The Soil Survey and Land Classification Center (SSLCC) of the National Agricultural and Forestry Institute (NAFRI) is responsible for soil surveys as well as agricultural and forest land classification, research on the management of agricultural land and fertilizer application. Soil maps and land suitability maps have been produced for the main agricultural areas and for the remaining areas data are now being produced.

TABLE 1
Land use for 1982 and 1989, with estimates for 2000

Land use groups/land/use & vegetation types	**Area (000 ha)**		
YEAR	**1982**	**1989**	**2000**
Forest	**11 636.8**	**11 167.7**	**10 700**
Dry dipteropcarp	1 235.1	1 206.5	1 155
Lower dry evergreen	88.6	85.5	82
Lower mixed deciduous	893.0	866.0	830
Upper dry evergreen	1 105.9	1 061.0	1 017
Upper mixed deciduous	7 492.4	7 448.4	7 136
Gallery forest	90.7	87.5	84
Coniferous	138.3	132.3	127
Mixed coniferous/broadleaves	293.2	280.5	269
Potential forest	**7 956.7**	**8 323.3**	**8 530**
Bamboo	1 457.0	1 531.9	1 260
Poorly stocked, including recovering shifting cultivation areas	6 499.7	6 791.4	7 270
Other wooded areas	1 545.4	1 444.4	1 300
Savannah/open woodlands	974.0	912.5	820
Heath & scrub forest	571.6	531.7	480
Arable Agriculture	**1 306.1**	**1 475.1**	**1 810**
Sedentary agriculture	708.7	849.5	1 130
Shifting cultivation & other upland systems	597.4	625.6	680
Grasslands	804.4	822.8	860
Other land areas	430.6	446.7	480
Barren land/rock	109.9	116.1	116
Urban	82.2	84.2	113
Swamps	34.1	35.4	35
Water	204.4	210.9	216
TOTAL	**23 680.0**	**23 680.0**	**23 680**
Land use groups/use & vegetation types			
Population (000)	3 346	3 977	5 234
Forest land per person (ha)	3.48	2.81	2.04
Potential forest & other wooded area per person (ha)	2.83	2.46	1.88
Arable agricultural & per person (ha)	0.39	0.37	0.35

Source: DOF 1992. Forest cover and land use in Lao PDR. Report No.5 1992. MOAF. NAFRI 2000.

To conserve and sustainable manage the land and soil, it is important to have information on slope, elevation, soil and existing land use. Knowing these factors, land use planning can be undertaken and an orderly switch from one from of land use to another appropriate form can occur. Information exists on slope, topography and altitude classes as well as existing land uses. Table 2 gives data on land use by sloping classes. This is taken from a nationwide reconnaissance survey of land use in Laos in 1989 with estimates for 2000. Information on slopes will not change over time, only on the land use.

Nearly all permanent agricultural land is in areas having slopes less than 5 percent, whereas 70 percent of shifting cultivation land and other upland farming is on slopes greater than 20 percent. This is a main reason why government is trying to stabilize shifting cultivation by 2010 and to demonstrate more sustainable land-use alternatives. Also, in many upland areas, the soil is unsuitable for annual crops. Land with a slope greater than 20 percent should not be farmed without measures to counter erosion, such as contour ploughing, strips of grass and/or trees along the contours at appropriate intervals, as well as terracing.

Sustainable use of forest and natural resources

The sustainable development of natural resources is not only national importance, but it is also significant from a regional and global perspective. Laos is rich in bio-diversity and has considerable areas of pristine forest: these are important globally. The forests are a source of much timber and many non-timber forest products, including wild animals and aquatic mammals. Such wildlife is important to rural communities for both subsistence and income generation. The forests are also important cattle grazing areas. There are 64 watersheds: 55 river systems contribute 35 percent of the water to the lower Mekong River system – while the remaining nine flow directly into Viet Nam on the northeastern border. Protecting these watersheds is of regional as well as national importance, particularly for lowland agriculture and fishing. Many watersheds are rich in biodiversity. The government recognizes their global importance and created 20 National Biodiversity Conservation Areas (NBCAs) and two corridors connecting three of these areas covering 3.4 million ha. These contain rare and newly discovered plants and animals and are the last remnants of large areas of unique forest types. Most NBCAs have populations living in them practicing shifting cultivation. Stabilization of this land-use system is, therefore, of paramount importance.

Over the past 20 years thousands of hectares of forest have been cleared and some wetlands drained for agricultural expansion. Some of this land was unsuitable for agriculture or should have been maintained in its original state. Thus, considerable pressure is being placed on natural resources and forestland to meet the increasing needs of and expanding population and to satisfy the government policy of improving living standards. The major objective of government is to properly manage both renewable and non-renewable natural resources so as to help meet their goals. However, especially in the agricultural sector, this has to be done in a sustainable and environmentally friendly way. Having a large forest area and a relatively low population density there is a considerable quantity of wood available to the population

Trees and their importance to farmers

Trees and forests are important components of the farming system and are essential for shifting cultivation. They supply fuel, building materials, food, fibre, medicines and many other NTFPs. They also contribute the bulk of grazing and browse to farm animals and are a significant source of non-farm income for rural people. While forest trees supply most of the products that farmers require, trees outside the forest, especially trees on farm are becoming more important especially as a way to generate income and as an input to sustainable agricultural development. Most arable and pastoral farming systems have trees as an integral component, the exception being lowland paddy production.

But even here, farmers plant tree/bamboo in some areas to at least provide shade, but usually to provide food, fibre and fuel.

TABLE 2
Lao PDR 2000: Estimated land use by slope and classification

Land use	Slope classes (%)					Total Area
	0-5	6-19	20-30	31-59	60	(ha)
Forest	2.35	462	3 731	3 030	962	10 700
Degraded forest, bamboo & other wooded area	1 548	593	4 046	2955	688	9 830
Shifting cultivation, other upland and fallow areas	139	56	313	138	25	680
Permanent agriculture	1 100	26	4	0	0	1 130
Grassland	126	27	332	297	78	860
Other land	319	29	47	38	47	480
Total	5 567	1 382	8 473	6 458	1 800	23 680
Percentage	24%	6%	36%	27%	7%	100%

Note: A slope of 100 percent is equivalent to 45 degrees.
Source: Nationwide Reconnaissance Survey: Report 5, 1992.MAF (DoF), modified to 2000 land use data.

Through the Shifting Cultivation/Agroforestry Research programme, the NTFP project, the EU micro-projects, the Lao-Swedish Forest programme and several other private and public initiatives, planting trees on farms has increased. Agroforestry initiatives, NTFPs and planting trees, bamboo and bushes for food, fruit, nuts, raw silk, paper bark, poles and timber are gaining momentum, especially where there is a developed market for these products.

Forest rules and regulations

On the one hand government and donors are encouraging tree planting. In the Forest Laws (Article 34: Promotion of Tree Planting), tree planting is promoted through various incentives, subsidies and regulations, including credit and tax incentives and the provision of planting material usually from improved stock. There is also an annual National Tree Planting Day June 1st when the population at large is encouraged to plant trees (Article 46, Forest Laws). Article 47 of the Forest Law specifies establishment of a forest and forest resource development fund to promote tree planting, among other things. However, to date the fund has only been established: through the Lao/ADB Plantation Programme, money can be borrowed to invest in planting.

Assessment of agriculture potential

Agriculture potential is assessed in terms of lowland rice, upland crops, tree crops and grazing lands. The assessment was done using existing digital data on forest cover and land use, soil, climatic condition, topographic condition, and unexploded ordnance (UXO)**.** The extent of agriculture potential area for each crop group and grazing land is seen in Boxes 1 and 2. This data shows that the total potential area for annual and perennial crops is some 3.1 million ha compared to 1.0 million ha of existing cultivated area.

WATER RESOURCES DEVELOPMENT

Introduction

The rivers of the Lao PDR contribute about 35 percent of total water volume to the lower Mekong river system. Protecting these watersheds is therefore of regional as well as of national importance, particularly for lowland agriculture and fisheries. During the past 20 years thousands of hectares of forest have been cleared for agricultural expansion. Considerable pressure is thus placed on natural resources and forests to meet the increasing needs of an expanding population and to satisfy governmental policy of improving living standards. Therefore, emphasis will be placed on ensuring proper land use planning and sufficient land allocation for all rural people; protecting catchment areas to reduce erosion and ensuring a more even flow of water.

BOX 1
Assessment of agricultural potential (%)

Potential area for crops	3 120 000 ha	13.2
Potential area for grazing land	1 093 000 ha	4 6
Less agriculture potential area	19 467 000 ha	82.2
Total	23 680 000 ha	100.0

BOX 2
Extent of UXO risk areas (%)

High	630 000 ha	2.7
Probable	3 260 000 ha	13.8
Minimal	19 790 000 ha	83.6
Total	23 680 000 ha	100.0

Surface water

The main rivers of the Lao PDR consist of the primary and secondary tributaries of the Mekong River. There are about 39 main tributaries in the Mekong River basin. There are ten main rivers with catchment areas exceeding 5 000 km^2: the Nam Tha, Nam Ou, Nam Xuang, Nam Khan, Nam Ngum, Nam Kading, Xe Banfai, Xe Bang Hiang, Xe Done and the Xe Kong rivers. The total watershed area of the main tributaries is estimated at about 183 000 km^2.

On the other hand, only two main rivers, namely the Nam Ma and the Nam Ka are located outside the Mekong River Basin. They expand into the eastern areas of Houaphan and Xieng Khuang provinces and flow directly into Viet Nam. Their total watershed is approximately 15 000 km^2. The Nam Ngum River has a large dam and reservoir in Vientiane province. Its total storage capacity is 7 billion m^3 and its surface water area attains 370 km^2 during the rainy season.

Monthly rainfall is estimated at each rain gauge station. Based on statistical analysis of the collected data monthly rainfall ranges widely from 1 240 mm to 3 770 mm overall. Total annual runoff of main rivers is estimated at 229.9 billion m^3 in an ordinary hydrological year, Annual runoff of the main Mekong River tributaries is estimated at 214 billion m^3 accounting for 93 percent of the total annual runoff. Annual runoff greater than 1 billion m^3 are identified in larger Mekong River tributaries such as the Nam Ngum, the Nam Kading, Xe BangHiang and Xe Kong. The annual runoff of rivers flowing directly into Viet Nam is estimated at 7.185 billion m^3 for the Nam Ma River and 8.196 billion m^3 for the Nam Ka River.

Groundwater

The only hydrogeologic information currently available for the Lao PDR overall is the *Preliminary Appraisal of the Hydrogeology of the Lower Mekong Basin* published by the Interim Mekong Committee in 1986. It shows that the Lao PDR is divided into two geological areas, the Annamian strata occupying most northern and eastern regions and the Indosinian sediments, mainly along the Mekong River. The Annamian region includes granites, metamorphics and palaeozoics. The Indosinian region consists of sandstones, siltstones, shales, mudstones, limestones, conglomerates and basalt.

There are three different aquifer systems. The Annamian aquifers occur at random. They are local systems that discharge locally into the river or its tributaries. As local flow systems, they are not part of regional flow systems and will not carry pollution into the regional groundwater system. Potential water supply from groundwater in northern Lao is considerable in view of the high amount of recharge available. Water quality should be reasonably good and for the most part potable but water will be iron rich. Yields up to 5 litres/sec can generally be anticipated.

The Indosinian group of aquifers, which have regional flow, includes rock strata of the Indosinian Moyennes and Superieures and is relatively young. They are mostly freshwater sediments, although three are horizons of brackish water, and one major zone of saline water yields of 12 to 24 litres/sec can be developed. Alluvial aquifers associated with Mekong River sedimentary deposits are not rated highly as aquifers.

Limestones in the central region are strictly Annamian in age, but their location places them logically in the Indosinian flow system. It has been described as having enormous groundwater resources. No notable investigation and study on the groundwater appears to have been conducted in the Lao PDR. In the early 1990s, the Mekong Secretariat conducted a project 'Review of Groundwater Data in the Lower Mekong Basin' and installed 18 observation wells: ten were installed

in the Vientiane plain and the rest along the Mekong River. The observation revealed the interesting fact that the Mekong River has very little influence on aquifers in the Vientiane plain.

TABLE 3
Development policies related to water & water resources

Sector	Development Policy
Hydropower	Reduce imported fuel Support rural development & reduce regional power imbalance Encourage private investment in hydropower development Earn foreign exchange for socio-economic development Minimize environmental impacts & Develop watershed management
Irrigation	Achieve food self-sufficiency, increase commodity production, reduce shifting cultivation Involve all stakeholders in irrigation development & management Coordinate irrigation schemes with other means of increased agricultural production Protect against flood damage
Navigation	Maintain current transport capability by river Improve navigation aids & information for safety travel Encourage use of river transport in wet season instead of poor roads Protect riverbanks from erosion
Fisheries	Collect information on the extent an nature of capture fisheries Develop infrastructure & human resources in fisheries management Promote development of aquaculture & regulate fishing activities
Urban water supply & water disposal	Increase amenities in urban areas by providing affordable & quality services in commercial water supply & sanitation
Rural water supply	Improve water supply & environmental health in rural areas Focus on inaccessible, poverty-ridden areas Encourage private water supply & sanitation ventures in easy-to-reach areas

Groundwater will be further developed as the main source of urban and rural water supply and small-scale irrigation in lowland areas far from surface water resources, such as southern and western Champassak province and the hinterlands of the Sebang Fai, Sebang Hieng and Sedone river valleys.

Water quality

Monitoring of water quality on the Mekong River and its tributaries is the responsibility of the water quality laboratory of the Department of Irrigation in the Ministry of Agriculture and Forestry (MAF). Monitoring began in 1985. At present there are 34 monitoring stations in operation: four on the Mekong and 15 on nine major tributaries. The remaining ten stations are at various locations potentially exposed to water quality degradation downstream of existing reservoirs and the That Luang wetland in Vientiane municipality. Water samples are usually collected monthly for chemical and biological analysis.

In general the water quality of rivers within the Lao PDR and the Mekong is considered good relative to global environment monitoring standards: the level of oxygen is high and the nutrient concentration is low. Sediment loads in the tributaries vary considerably from 41 tonnes/km^2/year to 345 tonnes/km^2/year. High levels of suspended sediment occur during the rainy season. Tributaries and river reaches with high sedimentation are the Sebang Hieng, Sedone, Nam Ou and the upper and lower stretches of the Mekong river.

The water and water resources law

The Water and Water Resources Law of 1996 defines principles, rules and measures in the administration, use and development of water and water resources. The law has 10 provisions and 49 articles focusing on the protection of water resources and watersheds, water resources planning and prevention of water pollution. Ministries active in water resources have been instructed to formulate ministerial regulations to reflect the intent of the law.

In setting the legal framework for water and water resources, government established the Water Resources Coordination Committee (WRCC) in April 1998 as a national apex body to improve coordination of multi-sectoral activities involving water use and to define and manage water allocations. The Asian Development Bank (ADB) provided the government with technical assistance in 1997-1998 to institutionally strengthen the WRCC. The vice-chairperson of STEA is the WRCC chairperson and representatives of seven organizations nominated by the Prime Minister's office. The Minister of Agriculture and Forests is WRCC vice-chair, Ministry of the Interior, MCTPC, Ministry of Public Health, Ministry of Justice, Lao National Mekong Committee (LNMC) and STEA. The WRCC has its own secretariat within STEA.

Water resources policy

There has been no clear overall water sector policy in the Lao PDR, but it could be gradually set up by augmenting and adjusting individual policies of water related sectors with the WRCC establishment. Government is further developing the legal and regulatory framework for water and water resources and for preservation of the environment to reduce conflicts between the sectors caused by development. The water-related sectors are hydropower, irrigation, navigation, fisheries, urban water supply and waste disposal, and rural water supply. The respective sector development policies related to water and water resources are briefly summarized below.

TABLE 4
Proposed programmes and projects for land and water resource development

Project/ Programme	Objective	Component
Strengthening LUP & LA & land titling in rural area	▪ Strengthen existing LUP/LA system through synthesis of macro-level planning based on national development goals micro-level planning based on local area development needs ▪ Improve monitoring & evaluation (M&E) of LUP/LA to encourage village management of agricultural, forestry & other resources ▪ Develop LUP/LA information storage procedure to facilitate future land titling & registration	▪ Networking of relevant government agencies in LUP/LA ▪ Development of National Implementation Plan based on criteria for prioritization ▪ Follow-up activities for LUP/LA villages ▪ Extension of field tested methodologies ▪ Implementation of training programme for national, provincial & district staff ▪ Refining M&E procedure ▪ Information storage system development
T/A on Nationwide Shared Water Resources Management	▪ Develop water use & distribution plan for agriculture, urban, industry & power sectors ▪ Monitor quality & quantity of water for different end-users	▪ Establish optimum water use among affected sectors. ▪ Establish adequate environmentally sustainable water resources development plans ▪ Provide adequate water & soil testing equipment & methodologies
Watershed Management Programme	▪ Sustain water resources for water related social & economic activities: hydropower, irrigation & fisheries ▪ Protect people & their properties & lands from floods & soil erosion ▪ Maintain sustainable agricultural production in all areas	▪ Establish procedures for integrated watershed management by development & implementation of watershed management plans where water projects have been developed or are planned ▪ Provide adequate water & soil testing equipment & methodologies
Agro Zone Classification, Land Management & Farming System Development	▪ Develop agro-zone classification maps ▪ Assist land use planning & cropping pattern ▪ Use remote sensing to help with land classification & land use.	▪ Expand land classification & crop suitability maps ▪ Establish feedback system for ground truthing to upgrade GIS data. ▪ Reconcile GIS & agriculture census data. ▪ Develop agro-zone classification maps
Soil & Water Conservation Technology Research Programme	▪ Develop appropriate technologies for soil & water management.	▪ Review completed & ongoing projects concerned with soil conservation ▪ Develop a soil technical support system
Irrigation Water Management Research Programme	▪ Develop appropriate technologies for irrigation water management	▪ Develop irrigation water management system for lowland & upland crops. ▪ Research effective participatory irrigation water management. ▪ Provide technical staff training (on job & in-country research courses).
Rehabilitation & Expansion of Meteo-hydrology Stations for Agricultural	▪ Strengthen weather forecast for agriculture development, increase food crop production & flood forecasting to mitigate agricultural damage	▪ Rehabilate hydrometerogical stations including agro-meteorology stations & renewal of instrument/equipment. ▪ Build new hydrometereologal stations including agro-meteorological station.

Development & Flood Control		▪ Provide modernized communication equipment ▪ Provide computer LAN system to upgrade collection-transferring-compilation-filing & analysis ▪ Improve weather & flood forecasting ▪ Build facilities to calibrate hydrological instrumentst & equipment test lab ▪ Institutional Improvement of operations & management ▪ Train DMH & Provincial Meteo-hydrology Office staff in participatory survey, planning, supervision of construction & overseas training ▪ Prepare educational programme for DMH & Provincial Hydromet Office
Support STEA for Environmental Friendly Agriculture Development	▪ Implement community based resource & land management groups ▪ Improved environmental data collection ▪ Assist formulating environmental impact regulations for agriculture, forestry & fisheries to support provincial environmental initiatives	▪ Promote community group formation ▪ Establish participatory data collection & analysis system ▪ Enhance reporting arrangements to STEA & agro-service industries.
Strengthening Weather Forecast System for Agriculture & Disaster Operation	▪ Secure agricultural production & mitigate disaster damage	▪ Build weather surveillance radar stations in northern & southern regions for real time tracking of tropic storms ▪ Construction of upper-air stations in Vientiane ▪ Upgrade weather & flood forecasting systems ▪ Install telecommunication system & establish network system ▪ Institutional improvement of operation & management ▪ Educational upgrading programme for DMH & provincial meteo-hydrological service office

Irrigation development

Background

The history of Lao irrigation can be traced back several centuries in the northern mountains. These irrigation systems are based on primitive water intake made by logs, soil and/or stone, and have been managed well by communities. From the 1960s, modern irrigation systems with concrete weirs and well-designed canals have been built with technical and financial assistance from foreign donors. Lao irrigation is classified by region in three types: (i) community managed gravity irrigation in the northern mountains (with a range of service area from one to over 300 ha); (ii) pump irrigation in the Vientiane plain and (iii) recently introduced pump irrigation along the Mekong River where most of the plain is flood-prone.

Current progress of irrigation development

As of 1999/2000 there are 19 170 irrigation schemes with a service area of about 295 000 ha in the wet season and 197 000 ha in the dry season. The irrigation area in dry season has rapidly increased from 29 000 ha in 1996 to 197 000 ha in 2000. Most irrigation schemes are of traditional weir type in the northern and central regions where the mountains prevail, while pump irrigation is concentrated in the southern region.

TABLE 5
Proposed programmes & projects for irrigation development

Project/Programme	Objective	Component
Community Managed Irrigation Sector Project-2 (CMISP-2)	▪ Increase agricultural production on sustainable basis ▪ Increase food security & incomes ▪ Improve watersheds by reducing shifting cultivation & promoting tree planting in northern rural areas though Irrigation Management Transfer (IMT)	▪ Select priority project from provinces ▪ Mobilize community to project activities ▪ Rehabilitate & develop community managed irrigation schemes ▪ Construct rural infrastructure including rural water supply & district feeder roads. ▪ Institutional & financial support including setting up village development ▪ Support income generating activities
Decentralized Irrigation Development & Management Project (DIDMP) ADB & France financed)	▪ Facilitate full transfer of irrigation schemes to farmers as pilot schemes	▪ Assist users though WUA to organize/join in irrigation systems rehabilitation & O&M ▪ Provide appropriate extension services ▪ Rehabilitate existing schemes in cooperation with WUA ▪ Provide PAFS/DAFO capacity building ▪ Provide gender initiatives in development programmes ▪ Support VDF processor cost recovery
Agriculture Development Project (ADB) (WB financed)	▪ Enhance agricultural productivity & encourage crop diversification & thereby increase overall agricultural production ▪ Target small & low income subsistence farmer, to improve smallholder food security & increase rural incomes in sustainable manner	▪ Rehabilitate irrigation facilities ▪ Construct & rehabilitate village access tract ▪ Construct village water supply facilities ▪ Establish Village Investment Funds (VIF) ▪ Enhance agricultural services for institutional strengthening ▪ Project implementation support
TA on Accelerated IMT	▪ Establish a data base on existing irrigation schemes ▪ Establish a data base on potential community managed irrigation schemes ▪ Provide the necessary information & recommendation for accelerating & supporting irrigation ▪ Management transfer (IMT) process	▪ inventory of existing irrigation schemes covering natural & human resources conditions, constraints & needs for improvement in agricultural production, irrigation area facility condition need & costs & other necessary information ▪ Inventory potential community managed irrigation schemes for natural & human resources conditions, agriculture ▪ Review & recommend schemas for management system including improved O&M, WUA capacity building, education & training of WUA members, IMT process & VDF management ▪ Prioritize existing schemes for rehabilitated, improved & potential schemes to be developed, prepared for short-medium-long term implementation
Community Managed Small-scale Irrigation Project	▪ Increase agricultural productivity though crop diversification & increase overall agricultural production on sustainable basis ▪ Increase food security & income ▪ Improve watersheds by reducing shifting cultivation & management in mountain areas	▪ Assist users though WUAs to organize to participate in rehabilitation or new construction & irrigation system O&M ▪ Provide appropriate extension service ▪ Rehabilitate existing schemes in cooperation with WUA ▪ Construct new irrigation schemes on a community participation basis. ▪ Implement IMT ▪ Provide capacity enhancement to PAFSs & DAFOs ▪ Provide systematic gender initiative in development programme ▪ Support VDF process for cost recovery

TA of Water Resources Development in Northern & Central Region	▪ Provide technical solutions & investment processes to stabilize rural agriculture & other sectors in northern & central regions, ensuring sufficient food in some areas & surpluses in others	▪ Study irrigation & domestic water resources, flood control, & environment in northern & central regions ▪ Prioritize projects & prepare implementation schedule
TAs for Best Irrigation Use of Exploited Water Resources for Diversified Agriculture Development Project	▪ Increase agricultural productivity, encourage crop diversification & thereby increase overall agricultural production on a sustainable basis. ▪ Increase food security & incomes though intensive farming systems	▪ Development study on medium & large scale irrigation schemes in cooperation with communities though best utilization of exploited/exploitable water resource development projects such as hydropower, water supply, flood control ▪ Study providing, building flood protection facilities for sustainable use of flood-prone areas ▪ Review & recommend management systems including improved O&M, WUA capacity building, education & training of WUA members, IMT process & VDF management ▪ Study providing appropriate extension services ▪ Study PAFS/DAFO capacity building
Best Irrigation Use of Exploited Water Resources for Diversified Agriculture Development Projects	▪ Increase agricultural productivity, encourage crop diversification to increase overall agricultural production on sustainable basis ▪ Increase food security & incomes through intensive farming systems.	▪ Rehabilitation & construction of medium & large scale irrigation schemes in cooperation with the community. ▪ Provision & construction of flood protection facilities for sustainable use of flood-prone sera ▪ Rehabilitate existing schemes in cooperation with WUA ▪ Implement IMT ▪ Provide appropriate extension services ▪ Provide PAFS/DAFO capacity building ▪ Support gender initiatives ▪ Support VDF management for sustainable project management.
Groundwater Irrigation Development & Management	▪ Promote high value commodity crops by best use of groundwater resources	▪ Investigae groundwater potential ▪ Provide pilot groundwater irrigation schemes ▪ Extend groundwater irrigation schemes link to rural development programmes
Technical Cooperation for Upland Crop Irrigation Engineering Center	▪ To extend research institutions to upland irrigated crops	▪ Construction of an upland crops irrigation engineering center & pilot areas ▪ Provide necessary data & research for development of upland crop farming. ▪ Establish training curricula to train concerned staff & farmers
Flood Disaster Mitigation	▪ Secure agricultural production & properties at flood-prone areas along Mekong River tributaries in wet season flooding	▪ Detail assessment of damaged area by wet season flooding ▪ Selecting priority areas ▪ Planning flood mitigation measures such as flood protection dykes, flood control gates, drainage pumps & other conceivable effective measures ▪ Rehabilitation & upgrading of flood protection facilities ▪ Rehabilitation & upgrading of existing river observatory system

An on-going major irrigation scheme is the Community Managed Irrigation Sector Project (CMISP) funded by ADB and OPEC. CMISP aims to improve more than 40 existing irrigation schemes in the central and northern regions. The communities are responsible for managing the improved facilities by organizing water user associations (WUAs). CMISP is expected to continue the project on a phased basis. Two similar schemes are to start in 2001: the Decentralized Irrigation Development and Management Sector Project (DIDMP) funded by ADB and France and the Agricultural Development Project (ADP) funded by the World Bank (WB). DIDMP is characterized as a pilot project exercising the IMP process, focusing on pump irrigation schemes in six selected provinces. ADP, covering four southern provinces, is really a rural development project including not only improvement of irrigation systems but also market oriented community development using village investment funds.

Irrigation management transfer (IMT)

Knowing that traditional irrigation systems have been efficiently managed by farmers' communities and also as from economic necessity the government must reduce agricultural sector subsidies, it set up a policy to transfer ownership and associated costs of irrigation to farmer users. Encouraged by the SIRAP experience, the government issued Prime Minister's Order No. 26/PM on transferring irrigation projects to community organizations (1998). The purposes of the decree are to: promote and support the role and responsibility of WUAs in the management of irrigation systems; assist in the reduction of the responsibilities of government agencies in the routine management of irrigation systems; ensure the smooth transition of the full transfer of ownership of all irrigation infrastructure to WUAs; and improve the efficiency of operations, management and water distribution on all irrigation systems.

Water development for irrigated agriculture in Pakistan: past trends, returns and future requirements

AVAILABLE WATER RESOURCES

Precipitation

Incident precipitation and river flows are the two major sources of surface water used to meet the requirements of agriculture and other sectors. Mean annual rainfall in Pakistan varies from less than 100 mm in Balochistan and parts of Sindh provinces to over 1 500 mm in the foothills and northern mountains. About 60 percent is received during the July to September monsoon. Most summer rains are not available for crop production because of rapid runoff during torrential showers. The contribution of rainwater to crops in the Indus Basin Irrigation System (IBIS) is about 16.5 billion m^3, some 10 percent of the mean annual river flow (Ahmad, 1993a).

The current drought was so severe that snowfall during the 2000-2001 winter season was significantly less than in normal years. Snow records are not available prior to 1999, but it is expected that snowfall might be less than the historical minimum or very close to that. Thus snowmelt available during the coming *Kharif* season will be much less than the mean flows.

Surface water resources

Pre-storage resources

Glacier melt, snowmelt, rainfall and runoff constitute the river flows. Inflow measurement facilities have been established at the rim of the Indus River tributaries and are thus referred to as rim station inflows. The rim stations for the western rivers are located at Tarbela, Attock, Mangla and Marala for the Indus, Kabul, Jhelum and Chenab rivers, respectively. The rim stations for the eastern rivers are located at Balloki and Sulaimanki for the Ravi and Sutlej rivers.

River flows are limited in the Rabi season because of limited glacier- and snowmelt and low rainfall during in the winter season. Western rivers provided 173 billion m^3 surface water in an average year during the pre-storage period of 1937 to 1967. The bulk of the river flow was during the Kharif season, with more than five times the flow of the Rabi season. Variability in flows of the eastern rivers was even higher than the western rivers. Before the Mangla and Tarbela storage dams were built, the eastern rivers contributed 26 billion m^3 of water to the Indus River system in an average year – of which 84 percent was during the Kharif season (Table 1).

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The contribution of the eastern rivers to the annual total inflow of the Indus River system was 13 percent, and 11 percent during the *Rabi* season – a significant contribution (as seen in Table 1).

Post-storage resources

Seasonal and annual river flows in the Indus river system are highly variable (Warsi, 1991; Kijine and Vander Velde 1992; Ahmad, 1993a; Mohtadullah, Rerman and Munir 1991). Analysis of daily and monthly flows indicated a similar trend (Bhatti, 1999). This variability restricts the assessment of the real contribution of storage in regulating flows of the river system; however, data were analyzed to evaluate the effect of key influences on the river flows in both western and eastern rivers.

TABLE 1
Variability of rim-station inflows to Indus River system (pre-storage period)

Probability (%)	Rim-station Inflows (billion m^3) for Pre-storage Period 1937-67						
	Western Rivers			Eastern Rivers			Total
	Kharif	*Rabi*	Annual	*Kharif*	*Rabi*	Annual	
Minimum	**111.0**	**19.1**	**134.5**	**9.6**	**1.7**	**11.3**	**145.8**
10	123.9	22.8	143.9	15.6	1.9	17.5	161.4
25	136.2	24.2	163.1	17.9	2.9	22.3	185.4
50	**144.5**	**26.3**	**173.0**	**22.1**	**3.3**	**26.2**	**199.2**
75	155.3	30.5	184.9	27.4	4.9	35.2	220.1
90	166.8	32.6	198.2	32.2	8.6	38.1	236.3
Maximum	**192.7**	**40.7**	**231.7**	**39.3**	**18.1**	**44.5**	**276.2**

Data Source: Water Resources Management Directorate, WAPDA.

River flows were limited in the *Rabi* season because of limited glacier- and snowmelt and low rainfall in winter. The western rivers provided 162 billion m^3 of surface water in an average year during the post-storage period, 6.4 percent less than the pre-storage period. The bulk of the river flow was during the *Kharif* season, which was five times the flow in the *Rabi* season. Variability in eastern river flows was even higher than in the western rivers. After the construction of the Mangla and Tarbela storage dams, the eastern rivers contributed about 10.7 billion m^3 of water to the Indus River system in an average year – 77 percent in the *Kharif* season (Table 2). The eastern rivers contribute 6 percent of annual total inflows – just 5.6 percent in the *Rabi* season.

Variability in river flows is a major limitation in the development of run-of-river type irrigated agriculture in the Indus Basin, especially to meet crop irrigation requirement during low flow period of the *Rabi* season and early and late *Kharif* season.

The recent drought was so severe that annual river flows downstream of the Kotri barrage during 2000-2001 were expected to be less than the historical minimum of 118.5 billion m^3 since 1922. This has created a situation of water crises in Pakistan and deepens interprovincial water conflicts.

Flows to the Arabian Sea (downstream of the Kotri barrage)

Annual variability of river flows downstream of the Kotri barrage has been very high. In normal years (50 percent probability), annual flow was reduced from 95.4 to 48.4 billion m^3 during pre- and post-Tarbela periods. The percent reduction in annual flows in the dry years (10 percent probability) was higher than during normal years, when flows were reduced from 31.6 to 13.5 billion m^3 during pre- and post-Tarbela periods (the probability of a dry year was one in five years in the pre-Tarbela period). The percentage reduction in wet year annual flows (>50 percent probability) was relatively less than in normal and dry years (see Table 3).

TABLE 2
Variability of rim-station inflows to Indus River System (post-storage period)

Probability (%)	Rim-Station Inflows (billion m^3) for Post-Storage Period 1968-1996						
	Western Rivers			Eastern Rivers			Total
	Kharif	*Rabi*	Annual	*Kharif*	*Rabi*	Annual	
Minimum	**94.0**	**19.9**	**114.9**	**2.3**	**0.0**	**3.6**	**118.5**
10	111.6	20.4	135.5	3.7	0.9	5.3	140.8
25	124.2	24.0	153.2	5.1	1.1	7.1	160.3
50	**136.0**	**27.1**	**162.1**	**8.2**	**1.6**	**10.7**	**172.8**
75	18.5	9.5	80.9	12.7	2.4	15.4	196.3
90	15.7	2.8	89.6	18.5	3.4	20.1	209.7
Maximum	**182.0**	**37.8**	**206.0**	**20.4**	**7.7**	**23.8**	**229.8**

Data Source: Water Resources Management Directorate, WAPDA.

TABLE 3
Flow variability to Arabian Sea (downstream Kotri Barrage), pre- and post-Tarbela periods

Probability (%)	Flow Downstream Kotri Barrage (billion m^3)					
	Pre-Tarbela Period (1940-75)			Post-Tarbela Period (1975-98)		
	Kharif	*Rabi*	Annual	*Kharif*	*Rabi*	Annual
Minimum	**10.0**	**0.0**	**10.0**	**11.6**	**0.05**	**11.9**
10%	31.3	0.3	31.6	13.5	0.1	13.5
25%	61.3	2.7	62.3	23.1	0.5	33.2
50%	**80.6**	**7.1**	**95.4**	**41.4**	**1.7**	**48.4**
75%	99.3	13.0	112.5	55.2	4.5	65.3
90%	115.8	20.3	130.8	85.4	6.9	99.5
Maximum	**133.8**	**25.5**	**159.0**	**108.9**	**15.2**	**113.4**

Data Source: Water Resources Management Directorate, WAPDA.

Rabi season flows in normal years (50 percent probability) were reduced from 7.1 to 1.7 billion m^3 during pre- and post-Tarbela periods, respectively. The effect was more pronounced in dry

years, where seasonal flows were even less than 0.5 billion m^3 in one of every four years. Reduction in seasonal flows was also observed during the wet years (>50 percent probability).

In summary, construction of the Kotri barrage reduced seasonal and annual flows below the Kotri due to the canal diversions. Seasonal and annual flows were further reduced during post-Mangla and post-Tarbela periods due to further increases in canal diversions at the Kotri barrage. Canal diversions at the Kotri barrage were increased from 5.42 to 10.8 billion m^3 (a 100 percent increase) during the post-Tarbela period. The probability of dry years was doubled after Tarbela compared to the pre-Tarbela period – a serious concern for downstream flows to maintain the delta ecosystem. The recent drought was so severe that annual river flows downstream of the Kotri Barrage in 2000-2001 will be less than the historical minimum flows of 10 billion m^3 since 1922.

Groundwater resources

Pre-storage resource picture

The Indus Basin represents an extensive groundwater aquifer covering a gross command area of 16.2 million ha. The water table was well below the surface and the aquifer was in a state of hydrological equilibrium before the development of the canal irrigation system. The recharge to aquifer from rivers and rainfall was balanced by outflow and crop evapotranspiration. When the canal irrigation system was introduced, percolation to the aquifer increased in irrigated areas of the Indus basin resulting in the twin menaces of waterlogging and salinity.

Although, there are disadvantages in having a high water table, it was used for irrigation by tubewells in fresh groundwater zones. The groundwater contribution for irrigation was 12 billion m^3 in the pre-storage period, 11 percent of the total water available for agriculture.

Post-storage resource picture

Estimated recharge to groundwater in the Indus Basin is 56 billion m^3, of which 36 billion m^3 occurs in areas of usable groundwater (Zuberi and Sufi 1992). The additional conveyance losses in the IBIS due to Tarbela contributed 10 percent to the overall recharge of groundwater (Ahmad 1993b). The 1979 WAPDA basin-wide survey indicated that the water table in 42 percent of the Indus Basin was less than 3 m and was classified as waterlogged, and the water table in 22 percent of the area was less than 2 m. In Sindh province about 57 percent of areas where the water table is less than 3 m (Table 4) was affected by waterlogging.

The 1979 basin-wide surveys were actually conducted from 1976 to 1978 and therefore represent early post-Tarbela conditions. Although, groundwater use has increased significantly in the last two decades, waterlogging still affects large tracts of land. About 22 percent of the Indus basin command area has a water table within 1.5 m. This rising water table indicates a worsening situation but it cannot be seen solely as a result of the Tarbela and Mangla reservoirs. Mangla/Tarbela-related increased waterlogging could be attributed to the lack of appropriate drainage facilities and inadequate improvements in irrigation management. The major reason was the failure or transition of SCARP projects and 10 percent added recharge to groundwater due to additional surface supplies from Tarbela.

Additional water supplies from the Mangla and Tarbela storage dams diverted to the newly constructed canal commands also contributed to recharge of groundwater. One example is the Chashma Right Bank Canal (CRBC) command area, where a rise in the water table has been observed to create a freshwater aquifer (Alurrade, 1998). However, for sustainability purposes, subsurface

drainage has to be provided to control water table depth. In fact the rise in water table was faster than expected and required an additional loan to introduce drainage.

TABLE 4
Indus plain provincial trends of water table depths and areas affected

Province	Total Area	Percent Area under Water Table Depth in metres					Total
	(mha)	<1	1-2	2-3	>3	Misc.	<3 m
Punjab	10.17	7	11	17	63	2	35
Sindh	5.57	6	24	27	40	3	57
Balochistan	0.35	1	6	9	84	0	16
NWFP	0.62	6	12	6	66	10	24
Total	**16.71**	**7**	**15**	**20**	**55**	**3**	**42**

NOTE: mha=million hectares

WATER QUALITY

Surface water quality

The water of the Indus River and its tributaries is of excellent quality. Total dissolved solids (TDS) range from 60 to 374 ppm, safe for irrigated agriculture, domestic and industrial uses (Bhutta 1999; PWP 1999).

TDS in the upper reaches at various rim stations ranges from 60 ppm during high flow to about 200 ppm during low flow. Water quality deteriorates downstream but remains well within permissible limits, with TDS at Kotri barrage in the lower reaches of the Indus ranging from 150 to 374 ppm. However, the TDS of tributaries such as the Gomal River at Khajuri, the Touchi River at Tangi Post and the Zhob River at Sharik Weir range from 400 to 1 250 ppm (IWASRI 1997).

Indiscriminate, unplanned disposal of agricultural drainage effluent (polluted with fertilisers, insecticides, pesticides), untreated sewage and industrial waste loaded with heavy metals and other toxic materials, is flowing into rivers, canals and drains, causing water quality deterioration in downstream waterways and water bodies. In 1995 an estimated 34 billion litres of untreated water was discharged daily into rivers, canals, drains and water bodies (Saleemi 1993). It was estimated that 350 and 250 million gallons per day (mgd) of raw sewage was produced in Karachi and Lahore, respectively, and that most was discharged untreated into varied waterways (Hussain 1995). Downstream this polluted water is consumed by people and causes numerous water-borne diseases.

At current growth rates, Pakistan's population is estimated to increase from 139 million in 1998 to 208 million in the year 2025, an increase of nearly 48 percent (Bhutta 1999). If no remedial measures are taken, the quantity of untreated sewage and industrial effluents will grow by at least the same proportion, further polluting surface waters so vital to meet the needs of human beings, livestock and plants. Pakistan's need to control pollution of surface water and to improve its quality is urgent.

Groundwater quality

Total annual groundwater potential in Pakistan is estimated at 67.9 billion m^3. The annual groundwater pumpage has increased from 4 billion m^3 in 1959 to 59 billion m^3 in 1996-1997. About 79 percent of the Punjab and 28 percent of Sindh have fresh groundwater suitable for agriculture (Afzal 1999; Bhutta 1999). Since most of the easily exploitable surface water resources have already been tapped, the future demand of water for agriculture, people and nature will have to be met largely through water conservation and further exploitation of already over mined groundwater resources.

Quality of groundwater varies widely, ranging from less than 1 000 ppm to more than 3 000 ppm. Some 5.75 million ha are underlain with groundwater having salinity less than 1 000 ppm, 1.84 million ha with salinity ranging from 1 000 to 3 000 ppm and 4.28 million ha with salinity more than 3 000 ppm.

Although investments in drainage have been significant in Pakistan during the last two decades, waterlogging still affects large tracts of land (World Bank 1994). Salinity and sodicity also constrain farmers and affect agricultural production. These problems are further exacerbated by the use of poor quality groundwater (Kijne and Kuper 1995). In fresh groundwater areas, excessive pumping by private tubewells leads to mining of the aquifer (NESPAK 1991) and redistribution of the groundwater quality (Zuberi and Sufi 1992; WRRI, MONA and IIMI 1999).

Recharge to the freshwater zone due to the additional supplies from Tarbela has contributed significantly in maintaining groundwater quality. However, recharge to the brackish groundwater zone created serious quality concerns for the disposal of the saline effluents despite creating a top layer of potable water for the concerned population (Ahmad 1993a). This problem was mainly due to the approach followed for drainage of area under the SCARPs in brackish groundwater zone, where saline groundwater (SGW) was pumped from deeper depths (Ahmad 1990).

Mining of groundwater, which is presently occurring in many areas, will cause intrusion of saline groundwater into the fresh groundwater areas. In addition, seepage of water from farmland will add dissolved fertilisers, pesticides and insecticides to groundwater. This will further increase pollution of groundwater and deteriorate its quality. The use of polluted groundwater for drinking may cause serious health hazard and its use for irrigated agriculture may adversely affect production potential of irrigated lands due to aggravation of the problem of salinity, sodicity and specific ion effects on crops and plants. It is essential to minimise groundwater pollution to improve its quality as far as possible through regulation of groundwater extraction and/or increasing the recharge in areas where mining of groundwater is taking place.

PAST TRENDS IN WATER USE

Agricultural water use: surface water

Indus Basin canal diversions

Canal diversions represent the total amount of water diverted at all barrages constructed on IBIS rivers. Water diverted to individual canals at their offtake from the barrages is a good indicator of the contribution and effect of the storage reservoirs (Mangla and Tarbela) including the IBP. A considerable increase in canal diversions of about 9 billion m^3 was observed during the post-Mangla period. A further increase of 12 billion m^3 was observed during the post-Tarbela period. Of this, the major increase was in the *Rabi* season (9.6 billion m^3 per annum) as shown in Table 5.

The contribution of the Tarbela dam to canal diversions during the *Rabi* season was almost 26 percent, significant because most staple food is grown then. However, the main objectives of the Tarbela dam were to provide storage for replacing water of existing canal commands of 1.8 million ha dependent on eastern rivers flow and improvement of supplies to canals off-taking from the Indus main channel commanding 6.9 million ha.

However, there was variability in the canal diversions in both the seasons. The percent variability between the highest and lowest post-Tarbela canal diversions was 25 and 17 percent during the *Kharif* and *Rabi* seasons, respectively. This shows that the stochastic nature of the river flows also has an effect on the canal diversions, in addition to the reduced storage capacity of the Tarbela (Table 6). This information along with shortages and surpluses can be used for planning new irrigation projects (Ahmad and Kutcher 1992).

TABLE 5
Historical canal diversions to IBIS under key influences

Key Influences	Period	Canal Diversions (billion m^3)		
		Kharif	***Rabi***	**Annual**
Pre-Partition	1940-1947	58.5	24.9	83.4
Partition	1947-1948	57.0	27.6	84.6
Dispute	1948-1960	63.4	30.4	93.8
Pre-Mangla	1960-1967	74.2	34.0	108.2
Post-Mangla	1967-1975	80.3	37.1	117.4
Post-Tarbela	1975-1980	83.7	47.0	130.7
Post-Tarbela	1980-1985	84.1	45.9	130.0
Post-Tarbela	1985-1990	81.6	46.4	128.0
Post-Tarbela	1990-1995	81.5	47.3	128.8
Post-Tarbela	1975-1995	82.7	46.7	129.4

Data Source: Water Resources Management Directorate, WAPDA.

The recent drought was so severe that annual canal diversions during 2000-2001 will be less than the historical minimum diversions of 116.5 billion m^3 in the post-Tarbela period (1975-2001). The reduced canal diversions to the extent of 30 percent of the mean are expected, which might be some 90 billion m^3. This reduction in canal diversions during the Rabi season 2000-2001 has adversely affected crops such as wheat, chickpeas, sugarcane and vegetables, as well as orchards. The drought was continuing and might be severe during April-June 2002, which will further affect sugarcane and also adversely affect the planting of cotton and rice crops.

Irrigation system losses and overall irrigation efficiency

The Indus River flows through alluvial plains and thus its losses and gains assume greater importance than would otherwise be the case (Ahmad 1993b). In its system losses generally occur in the rising stage from April to July. During falling flows, covering the periods from end of July to September and from October to March, the rivers usually gain water. Analysis of annual historic gains and losses was conducted using the data between the period from 1940-1941 to 1993-1994 for the Kharif and Rabi seasons (Table 7).

Earlier studies revealed that conveyance losses in canals varied between 15 to 30 percent (Ahmad 1993b; Harza 1963; IACA 1966; LIP 1966). The Water Sector Investment Planning Study (WSIPS, 1990) provided a synthesis of the work done by WAPDA (1979) on canal conveyance losses for 24, 5 and 14 canal commands in the Punjab, NWFP and Sindh provinces, respectively. The average canal losses computed were 23, 12 and 20 percent for the canal commands of the Punjab, NWFP and Sindh provinces, respectively. These losses were about 21 percent for the whole basin.

TABLE 6
Variability of post-Tarbela canal diversions in IBIS

Probability (%)	Canal Diversions (billion m^3)		
	Kharif	***Rabi***	**Annual**
Minimum	70.7	43.0	116.5
10	72.2	43.7	118.9
25	76.0	44.4	122.1
50	81.0	46.9	126.4
75	84.2	47.6	130.6
90	87.7	48.6	134.6
Maximum	88.0	50.3	135.4

Data Source: Water Resources Management Directorate, WAPDA.

TABLE 7
River gains and losses in the Indus River System

Period	River Gains and Losses (billion m^3)		
	Kharif	***Rabi***	**Total**
Pre-Mangla 1940-1967	-20. 23	5.71	-14.52
Pre-Tarbela 1967-1976	-10.80	3.64	-7.16
Post-Tarbela 1976-1998	-14.36	1.02	-13.34
Average 1940-1998	-16.54	3.61	-12.93

Data Source: Water Management Directorate, WAPDA

Systematic work on watercourse loss measurement was initiated jointly by Colorado State University and WAPDA. Based on two systematic studies of 40 and 61 watercourses, actual losses were 47 and 45 percent, respectively. Field application losses were about 25 percent (Ashraf, 1977; WAPDA 1979; Trout and Kemper 1980; PARC-FAO 1982). Average losses of 21, 40 and 25 percent were used to compute losses from canals, watercourses and fields, respectively, in this paper. These losses provided canal, watercourse and field application efficiency of 79, 60 and 75 percent, respectively. Thus the overall irrigation efficiency is 36 percent (Ahmad 1990).

System losses corresponding to canal supplies in IBIS ranged from 82.5 to 84 billion m^3 during the post-Tarbela period, or about 64 percent of water delivered to IBIS (Table 8). In fresh groundwater areas, this induced recharge resulted in accelerated installation of tubewells to exploit the resource.

Groundwater

Groundwater contribution

From 1976 to 1997, the groundwater contribution to irrigated agriculture has doubled, rising from 31.6 to 62.2 billion m^3 (GOP 1998). The country has made considerable progress in the development of innovative and indigenous tubewell technology. However, with higher electricity tariffs and diesel fuel prices and soil salinity in marginal quality zones, there was a decline in groundwater pumpage during 1997-1998. It was about 50 billion m^3 – a significant decrease (Table 9). However, groundwater contributed 38 percent of surface water available at the canal head.

TABLE 8
Irrigation system losses corresponding to canal supplies to IBIS

Description of Losses	Annual System Losses (billion m^3)			
	1975-80	1980-85	1985-90	1990-95
Canal Conveyance losses	27.4	27.3	26.9	27.0
Watercourse Conveyance Losses	41.3	41.1	40.4	40.7
Field Application Losses	15.5	15.4	15.2	15.3
Total Losses	84.2	83.8	82.5	83.0
Total Canal Diversions	130.7	130.0	128.0	128.8
Overall Irrigation Efficiency (%)	36	36	36	36

Another contributing factor was the transition of public tubewells under SCARPs, where communities refused to take over deep tubewells because of high O&M costs. SCARP transition projects were aimed at reducing public involvement in the groundwater sector by closing down or transferring public tubewells to the water users (World Bank 1988).

Droughts during 1999-2000 and 2000-2001 forced farmers to install tubewells to meet shortfalls in canal supplies. It is expected that canal supplies during 2000-2001 will be significantly less than the historical average. Thus the groundwater abstraction was much more than the recharge; rather in certain areas farmers faced problems of the lowering of the water table.

Tubewell development

Enhanced power generation from Tarbela and the government policy of price incentives for electric power motivated farmers to install electric tubewells. Consequently, there was more than threefold increase in the number of tubewells in 1990-91 as compared to the situation before Tarbela. The innovative and low cost development of tubewell technology in the country further motivated the farmers to install diesel-operated tubewells.

Progressive increases in electricity tariffs starting in the early 1990s resulted in stagnation of the growth of electric tubewells. However, a twofold increase in diesel tubewells was observed during 1990 to 1995. This is a clear indication of the effect of Tarbela and power policy of the government during the late 1970s and 1980s on the growth of tubewells and development of innovative tubewell technology (Table 10).

The drought of 2000-2001 was so severe that farmers in the Punjab and Sindh provinces have installed tubewells at a very rapid rate. It was expected that about 60 000 tubewells or lift irrigation systems were to be installed in 2001 to meet the historical shortfall in canal supplies.

TABLE 9
Pre- and post-Tarbela groundwater contribution to irrigation water supplies

Key Influences	Period	Groundwater Contribution (billion m^3)	Increase in Groundwater Contribution (%)	Contribution as Percent of the Canal Diversions
Pre-Mangla	1965-66	11.3	-	10.0
Post Mangla	1967-68	14.5	28.3	12.4
Post Mangla	1970-71	21.6	91.2	19.7
Post-Tarbela	1975-76	31.6	179.6	25.2
Post-Tarbela	1980-81	40.2	255.8	29.6
Post-Tarbela	1985-86	48.3	327.4	39.6
Post Tarbela	1990-91	54.3	380.5	39.2
Post Tarbela	1995-96	61.0	439.8	46.9**
Post Tarbela	1996-97	62.2	450.4	47.8**
Post Tarbela	1997-98	49.6	338.9	38.2**

Source: Agricultural Statistics of Pakistan, Ministry of Food, Agriculture and Livestock, 1998.
* Base year of 1965-66 is used for computations.
** Average value of canal diversion of 130 billion m^3 is used for computations.

TABLE 10
Tubewell development in Pakistan

Key Influences	Period	Number of Tubewells			Percent Increase		
		Electric	Diesel	Total	Electric	Diesel	Total
Post-Mangla	1970-71	36 921	60 301	97 222	-	-	-
Post-Tarbela	1975-76	60 386	100 569	160 955	63.6	66.8	65.6
Post-Tarbela	1980-81	83 855	115 818	199 673	127.1	92.1	105.4
Post-Tarbela	1985-86	99 224	158 058	257 309	168.7	162.1	164.7
Post-Tarbela	1990-91	113 635	226 205	339 840	207.8	275.1	249.6
Post Tarbela	1995-96	113 823	369 962	483 785	208.3	513.5	397.6

Source: Agricultural Statistics of Pakistan, Ministry of Food, Agriculture and Livestock, 1998.

Domestic water supply

The water supply and sanitation sector in Pakistan is characterised by an extremely low level of coverage, particularly in rural areas. Presently, 80 percent of the urban population have access to piped water supply, whereas only 11 percent of the rural population benefits from this facility (PWP 1999). Table 11 shows the present water supply to various urban centres in Pakistan.

Water supply systems in Pakistan's urban centres are based on either using surface water or groundwater abstraction through tubewells. The cities which depend on surface water for their

drinking water needs include Islamabad, Karachi and Hyderabad. Lahore, Peshawar, Faisalabad, Abbotabad and Quetta are mostly supplied by groundwater.

Nearly all cities depending on surface supplies face moderate to acute shortages, but Lahore and Peshawar are somewhat better off due to a high yielding aquifer.

Rural areas depend on groundwater for domestic water where available, but in irrigated areas underlain with saline groundwater, canal waters are used to satisfy domestic requirements. Outside the canal commands, where groundwater cannot be depended upon, rural water supply depends on the available stream flows in upland areas or on rainfall collected in natural depressions, such as Tobas in the Cholistan desert. In such arid locations, the local populace must travel long distances to procure drinking water – a task assigned to women.

TABLE 11
Estimated water and sewage flows in cities

City	Population 1998 (million)	Water Supply		Sewage Flow		
		Rate (gpcd)	Total (mgd)	Ratio (%)	Rate (gpcd)	Total (mgd)
Islamabad	0.525	80	4 200	80	64	3 360
Karachi	9.269	60	55 616	80	48	44 492
Lahore	5.063	80	40 508	85	68	34 432
Faisalabad	1.977	50	9 886	80	40	7 909
Multan	1.182	50	5 912	80	40	4 730
Hyderabad	1.151	50	5 756	80	40	4 605
Gujranwala	1.124	50	5 624	80	40	4 499
Peshawar	0.988	60	5 928	80	48	4 742
Quetta	0.560	40	2 241	80	32	1 793
Sargodha	0.455	40	1 821	80	32	1 457
Sialkot	0.417	45	1 879	80	36	1 503
Sukkur	0.329	50	1 646	80	40	1 317
Mardan	0.244	50	1 223	80	40	978
Kasur	0.241	40	967	80	32	773

* gpcd–gallons per capita per day
** mgd–million gallons per day

It is estimated that present water demand for combined domestic and industrial uses is 3 302 mgd, whereas available water for the purpose is 2 369 mgd (PWP 1999; NESPAK 1998). Therefore, there is a net deficiency of 22 percent of total domestic water requirement.

Severe drought has affected domestic water supply availability. Surface water availability in the Simly dam in Islamabad has fallen to 40 percent of the requirement: the Capital Development Authority is rationing water on alternate days to the citizens of Islamabad.

Sanitation and sewerage

Pakistan's coverage for sanitation services is lower than the water supply coverage, i.e. only 60 percent and 13.5 percent in urban and rural areas, respectively. In most cities, wastewater from the municipal areas as well as industrial effluent is disposed untreated to natural surface water bodies. Table 11 shows the sewage generation of several urban centres.

In urban areas, sewerage consists of sewage collection and a disposal system. In cities sewage is collected through RCC pipes and open drains. Collected sewerage is disposed of in nearby water bodies through gravity or by inducting sewage pump stations in the system. In areas where sewage collection system is non-existent, sewage is discharged into groundwater through soakage wells, sometimes even without passing through septic tanks.

In rural areas, proper collection and disposal is almost non-existent. Sewage is collected through open drains and disposed of in open fields, where it usually forms huge ponds.

At present, there is little treatment of effluent in municipal areas. Only a few cities in Pakistan have proper treatment facilities. According to a recent study, most plants are not in operation.

Industrial water use

Few industries have proper effluent treatment facilities. Generally multinational or export-oriented factories are forced to have treatment facilities.

Major industrial estates are found in Lahore, Faisalabad, Karachi, Hyderabad, Peshawar, Hattar, Kasur and Sialkot. The estates discharge effluent without treatment into nearby streams, to flow by river to the sea. Disposal of untreated industrial waste from isolated plants is allowed in open fields or nearby water bodies. Such ponds can be seen in various industrial estates.

Past trends and returns in irrigated agriculture

Irrigated and cultivated areas in IBIS

In the pre-Tarbela period, there were considerable water shortages and the actual water application to crops was only about three-fourths of the actual irrigation requirement. The transfer of Indus water to priority areas aimed to increase canal flows up to the limit of canal capacities. The irrigated area projected for the years 1975, 1985 and 2000 was 14.1, 16.4 and 17.9 million ha, respectively. The total cultivated area projected for those years was 19.4, 22.0 and 23.8 million ha respectively (Table 12).

Analysis of projected and actual areas in IBIS indicates that actual irrigated areas during 1997-1998 was 18.0 million ha, slightly higher than projected for the year 2000 by the Lieftinck Report of 1968. The actual cultivated area during 1997-1998 was 22.0 million ha, 7 percent less than projected for the year 2000 by the Lieftinck Report. This shows that the irrigated area target has been achieved (Table 12) but the total cultivated area target was not achieved as per projections for the post-Tarbela period.

As a result, there was a considerable expansion in canal irrigation in the Indus basin from 10.1 million ha in 1974-1975 to 14.7 million ha in 1997-1998. The 4.6 million ha increase during the post-Tarbela period can be attributed to additional supplies from the Tarbela dam and other diversion schemes. Tubewell irrigation increased from 2.8 million ha in 1974-1975 to 3.2 million ha in 1997-1998 (only tubewell commands). In addition, within the 1997-1998 canal command area (6.9 million

ha), tubewells provided water to supplement canal supplies, while in 1974-1975 this facility was not available. Tubewell installation within the Punjab canal command area was concentrated in the Mangla command.

TABLE 12
IBIS projected and actual, irrigated and cultivated areas

Period	Irrigated Area (mha)		Cultivated Area (mha)	
	Projected	Actual	Projected	Actual
1975	14.1	13.3	19.4	19.6
1985	16.4	15.3	22.0	20.6
2000	17.9	18.0	23.8	22.0

NOTE: mha=million hectares.

Source: Lieftinck Report, Vol. I, 1968; Agricultural Statistics of Pakistan, Government of Pakistan.

Cropped areas in IBIS

At the macro level, a significant change in cropping patterns resulted from increased availability of water from the Tarbela dam. Increased cropped areas of food grains and cash crops such as wheat (36 percent), rice (39 percent), cotton (44 percent) and sugarcane (52 percent) were reported, while cropped areas of coarse grains and conventional oilseeds decreased. The overall increase of cropped areas was 39 percent (Table 13).

Although cropped areas were not in the Lieftinck Report, it can be estimated from cropping intensity. Thus actual cropped area was less than projected in the post-Tarbela period.

TABLE 13
Cropped area of selected crops in Indus Basin irrigated agriculture

Crops	Cropped Area (mha)					Increase (%) 1971-1975 to 1990-1995
	1971-1975	1976-1980	1980-1985	1986-1990	1990-1995	
Wheat (R)	5.93	6.49	7.24	7.60	8.06	36
Cotton (K)	1.92	1.91	2.22	2.53	2.76	44
Rice (K)	1.51	1.88	1.98	2.01	2.10	39
Sugarcane (A)	0.61	0.76	0.90	0.82	0.93	52
Oilseeds (K&R)	0.59	0.53	0.41	0.41	0.61	4
All Fruits (A)	0.20	0.26	0.36	0.44	0.50	150
Total Area	10.76	11.83	13.11	13.91	14.96	39

Source: Agricultural Statistics of Pakistan, Government of Pakistan.
R = rabi; K = kharif; A = annual.

Land in the Indus basin is not a limitation. Irrigation is essential for crop production because of an arid environment, where rainfall contributes 10-20 percent of crop evapotranspiration in major parts of the IBIS. However, increased number of tractors, availability of planting machinery, credit support helped to increase cropped area. The increase in population was another reason, which influenced the increase in cropped area.

The major *rabi* crops in the Tarbela command area are wheat, fodder and horticultural crops. Sugarcane also needs irrigation during *rabi* season and thus competes for water with *rabi* crops. The trend of *rabi* crop areas in Tarbela shows considerable increases in area under wheat, fodder, sugarcane and horticultural crops. Wheat is a leading food grain for human consumption, while its straw is a source of cheap roughage for livestock. Generally, farmers consider water as a key input; with sufficient water availability; they normally increase cropped area.

Increased planting of sugarcane is primarily due to availability of additional irrigation water from the Tarbela reservoir as it is a high water demand crop. Other factors that contributed towards this increase were the development of the sugarcane industry and the road infrastructure, both providing necessary backward and forward linkages for growth.

Cropping intensity

In the Lieftinck Report, projected cropping intensities were given for Punjab and Sindh provinces, instead of the Indus Basin as a whole. In the Punjab irrigated area, actual intensity was 122 and 117 percent in 1985 and 1998, respectively, compared to projected values of 131 and 150 percent. In Sindh, actual cropping intensity was 124 and 132 percent in 1985 and 1998, compared to the projected 115 and 137 percent (Table 14). Increased cropping intensity in the post-Tarbela period was less than projected. The low cropping intensity could be attributed to problems of waterlogging and salinity, marginal quality groundwater use, increased areas of high water demand crops and insufficient improvements in irrigated agriculture.

As a result of increased canal diversions from 95 billion m^3 in 1960 to 126 billion m^3 at present and changes in the macro-economic environment, Indus basin farmers have increased their annual cropping intensities from the original design of 50 to 70 percent (over 100 years ago) to an average 120 percent in 1993-1994 (John Mellor Associates and Asianics, 1994). The present study confirms these observations – a cropping intensity of 117 percent was achieved by Punjab province in 1998. Pubjab represents about 70 percent of Pakistan's cropped area.

TABLE 14
Projected and actual cropping intensity in the IBIS

Period	Cropping Intensity (%)			
	Punjab Province		Sindh Province	
	Projected	Actual	Projected	Actual
1965	95	-	90	-
1975	114	105	100	116
1985	131	122	115	124
2000/1998	150	117	137	132

Source: Lieftinck Report, Vol. I, 1968; Agricultural Statistics of Pakistan, Government of Pakistan.

Increased cropping intensity has intensified pressure on surface water resources (cheap freshwater) and translated into a significant interference of upper and middle reaches water users into the operation of the irrigation distribution system. Therefore, farmers – particularly at the tail end – have installed many private tubewells to tap fresh groundwater resources for flexibility in water availability to meet their demand.

FUTURE WATER NEEDS AND AVAILABILITY

Future water needs for irrigation and non-irrigation sectors were computed for 2010. The irrigation sector includes water needs for agriculture, farm forestry, aquaculture, livestock and wetlands. The non-irrigation sector includes largely the domestic and industrial water needs. Present and future water needs and availability is presented in Table 15.

Present and future irrigation water needs

Net irrigation water requirement for crops in Pakistan is about 100 billion m^3 for the year 2000. Rainfall was disregarded in estimating net irrigation water requirements, but it was assumed that a 10 percent contribution of rainfall in the basin is required for leaching to maintain the salt balance in the root-zone.

The agriculture growth rate targeted by the Ministry of Food, Agriculture and Livestock for the next decade (2000-2010) is 5 percent per annum. This would be achieved through increasing the cropped area by 0.5 percent per annum and raising productivity by 4.5 percent per annum for the next decade. The increase in cropped area of 0.5 percent per annum will be achieved by providing additional water to increase cropping intensity in irrigated area of the Indus basin. Increased availability of additional water will be mainly through saving water from existing losses; new storage reservoirs will not be available during the next decade, even if the construction started now. Instead there will be reduced available storage capacity in the basin due to continuous sedimentation of the Tarbela and Mangla reservoirs.

Increased productivity of 4.5 percent per annum would also require more reliable and adequate availability of water. Additional water requirement will be about 1 percent (1.26 billion m^3) of existing canal supplies per annum. In addition, the annual loss of storage reservoir capacity is estimated as 0.30 billion m^3 per annum.

Current mean annual canal diversions to the Indus command area total 126.4 billion m^3. Additional canal supplies required to meet 5 percent growth in agriculture and to meet annual loss of live storage capacity of existing reservoirs due to sedimentation come to 1.56 MAF.

For the next decade, the additional irrigation water required to achieve 63 percent growth in agricultural production is 13.3 billion m^3 (based on 1.26 billion m^3 per annum), which is a considerable amount of water. Systematic efforts are needed to find new resources of water through improved management of water in the Indus basin and areas outside the basin. The future net irrigation water requirement for crops for the year 2010 is 113.3 billion m^3 (Table 15).

The assumption was made that no additional storage will be available for the year 2010 compared to the year 2000. Construction of large storage reservoirs would require a period of 10 to 12 years. Water management will be the only workable option for the next decade.

The water budget presented in Table 15 seems quite different than budgets presented by other authors, including the Water Vision 2025 (PWP 2000). Actually the problem arises when experts entered into the estimation of gross water requirement, which is a function of efficiency and improved operational management of canals and efficient water use. Thus water budget must be seen in the context of the net water requirement. The budget made on the basis of gross water requirement supports the need for further water development and underestimates the potential for improved water management.

TABLE 15
Pakistan water requirement and availability, 2000 and 2010

Requirement/Availability	Year	
	2000	2010
Net Water Requirement		
Net Irrigation Water Requirement	100.0	113.3
Net Non-Irrigation Water requirement	7.3	10.7
Total Net Water Requirement	107.3	124.0
Net Water Availability		
Mean Annual Canal Diversions	126.4	126.4
Canal Water Availability for Consumptive Use	44.9*	51.3**
Groundwater Availability for Consumptive Use	50.0	50.0
Total Surface and Groundwater Availability	94.9	101.3
Shortfall	12.4	22.7

*Based on 79, 60 and 75 percent of canal, watercourse and field application efficiencies.
**Based on 85, 65 and 80 percent of canal, watercourse and field application efficiencies.

Present and future non-irrigation water needs

The gross water requirement for non-irrigation needs was 7.3 billion m^3 for the year 2000. This will increase to 10.7 billion m^3 for the year 2010, based on a growth rate of 4 percent per annum for increased non-water needs due to a growth in population and coverage of domestic and industrial water supplies (PWP 2000). Details are provided in Table 15.

NATIONAL PLANS FOR CURRENT AND FUTURE WATER NEEDS

National plans and programmes

Shortfall in water use would increase from 12.4 billion m^3 to 22.7 billion m^3 in the next decade (2000-2010) even with an increase in overall irrigation efficiency of 44 percent compared to the current efficiency of 36 percent. Thus water resources development and management in the next decade will not make the country self-sufficient in irrigation and non-irrigation water needs. On the one-hand, intra-sectoral demand for additional water is increasing rapidly while on the other, opportunities for further development of water resources or maintaining their use to existing levels are diminishing faster than the expected pace. Thus the challenge for the next decade will be the effective implementation of a state of the art management cum development strategy.

Approach encompassing the development of additional reservoirs, integrated water management and use, introduction of water efficient techniques, containment of environmental degradation, institutional strengthening, capacity building and human resource development will have to be implemented (Planning Commission 2001).

Issues and objectives

The Planning Commission of Pakistan in its water sector strategy outlines water-related issues as:

- water shortages;
- seasonality in water availability and in-flexible canal irrigation system;
- inequities in water distribution;
- inadequate O&M funding and poor cost recovery;
- increased waterlogging and salinity hazard due to poor maintenance;
- excessive groundwater pumpage in certain regions and resulting in secondary salinization;
- effluent disposal and related environmental issues;
- absence of conducive environment required to introduce and implement water efficient irrigation techniques and practices;
- lack of private sector participation;
- deteriorating institutional capacity of key water sector institutions; and
- poor linkages among water, agriculture and rural development policies and strategies.

Objectives for the next decade (2000-2010) are to have sustainable development and integrated management of water resources and use, to meet the anticipated shortfall in water availability and need. This would be achieved through a comprehensive strategy of development cum management in the light of key issues identified for the sector. The specific objectives would address the key issues.

Planned options for meeting water shortages

Options outlined by the Planning Commission can be divided into two broad categories, the first including augmentation measures such as:

- constructing new reservoirs;
- raising the level of the Mangle dam;
- desilting the Tarbela dam;
- constructing carry-over dams;
- constructing small and medium size dams;
- harnessing hill-streams; and
- exploiting remaining groundwater potential.

Second category options include conservation and management measures:

- lining canals/watercourses with a priority to brackish groundwater areas;
- changes in cropping pattern to adjust for water availability; and the
- using high efficiency irrigation techniques.

Targets of the three year plan

Planning Commission has prepared a three-year plan considering the above-mentioned objectives and the options available. The physical targets of the three years programme of the water sector are:

- installing 660 SCARP tubewells;
- transition of 3 000 SCARP tubewells;
- rehabilitation/remodelling of 1 226 km of surface drains;
- constructing 728 km of new drains;

- building 301 km of flood embankments and 83 spurs;
- improving 15 000 watercourses; and
- precision land levelling of 45 000 ha.

THE VISION FOR 2010

Challenges

Agriculture sector

Research and development community is facing three challenges. The first challenge faced by irrigated agriculture is to raise production and productivity in favoured environments. Second, the challenge is to enhance production and productivity in less favoured environments such as the Balochistan valley, Rod-Kohi, the Barani lands and riverine areas. The third challenge faced by the country is that in the process of productivity enhancement the resources have to be upgraded rather degradation.

Population by the end of 2010 will be 171 million based on medium projections. A 30 percent population increase will require at least the same increase in food and fibre production to meet national requirements. Coupled with Pakistan's objective of increasing exports and reducing imports, it is more realistic to achieve 63 percent increase in agricultural production.

Targeted 63 percent increase in agricultural production would demand 13.3 percent increase in water availability. This additional water will come solely through savings of existing losses.

Domestic and industrial sectors

Urban and industrial sectors' development community is facing three challenges. The first challenge faced by the urban and industrial sectors is to raise level of quality of service and reliability in water supply in large metropolitans and industrial states. Secondly, the challenge is to extend the access to piped water supply in small towns and rural areas and isolated settlements. Third challenge faced by the country is that in the process of provision of safe water supply to the urban areas and industrial states the water resources have to be upgraded rather degradation in terms of environmental concerns like management of sewage and industrial effluents. Rather the sources of sanitary and industrial effluents have to be blocked prior to entry into freshwater ways.

Population by the end of 2010 will be 171 million based on medium projections. The increase of 30 percent in population would require at least same level of increase in domestic water supply to meet the country's requirement. Coupled with country's objective of alleviating poverty and quality life, it is more realistic to achieve a level of 48 percent increase in access to safe water supply.

Targeted 48 percent increase in provision of safe water supply would demand 10.4 billion m^3 of water for urban and industrial sectors. This additional water will come mainly through savings of existing losses.

Scenario

Vision 2010 is to increase agricultural contribution to GDP from Rs. 150 billion to Rs. 244 billion, a 63 percent increase. This would require increasing agricultural production by at least 50 percent with more emphasis on high value commodities such as milk, meat, vegetables and fruit to provide balanced nutrition to the population.

The driving issues which affect this scenario are population, economic growth, technological progress, social process, environmental concern, awareness and education and management levels.

RECOMMENDATIONS

Unresolved issues were identified which need to be addressed in the next decade. It is inappropriate to build recommendations for the irrigation subsector without considering the water sector as a whole (irrigation and non-irrigation sectors). Therefore, some tentative recommendations are:

- Comprehensive planning of the water sector coupled with integrated development and management of irrigated agriculture is essential to achieve self-reliance in agricultural production and sustainability of the resource base.
- Efficiency of water conveyance must be seen in the context of groundwater quality, as any loss of water in the brackish groundwater zone is not retrievable in terms of quality. Therefore, canal and watercourse lining programmes should be given priority in the brackish groundwater zone.
- Research/development of low-cost, effective linings for canals and watercourses should be strengthened.
- Local development of pressurised irrigation systems (including development of water and energy efficient pumping systems) should be encouraged. Private sector irrigation companies should be encouraged to provide services to farmers on a turnkey basis. Unemployed agricultural engineers should be trained to begin irrigation companies which can also provide domestic water supply and sanitation in urban areas.
- Productivity and sustainability research should address issues of water scarcity and inequity.
- Pilot projects in all major canal commands should be initiated to address issues of canal operational management, institutional reforms, productivity and sustainability.
- Farmers' organizations at the distributary canal level should be given authority and financial autonomy. Agriculture extension must reposition activities to be more responsive to farmers' organizations. The irrigation system is managed on the basis of irrigation districts, whereas agriculture extension is organised by administrative boundaries. There is a need to organise irrigation and agriculture sectors both on the basis of irrigation districts in the Indus basin and valley basis in the mountainous areas.
- Provincial on-farm water management programmes should address both surface and groundwater issues. They must reorient their technical backstop support system to respond to farmers' organizations.
- Surface water resources especially the small dams used for provision of domestic water supply have to be increased to meet future needs. The losses of pipeline supply systems have to be decreased to provide additional water. Mass awareness programmes have to be initiated to motivate domestic and industrial water users' in conservation of water.
- Emphasis should be given to recycling and re-use of water including wastewater management; and.
- Research on low-cost and low O&M treatment plants for sewage and industrial effluents should be initiated on an urgent basis.

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Investment in land and water in the Republic of Korea

INTRODUCTION

For the Korean government, 'food security' has been a centrally important agricultural policy. The critical importance of food security was widely understood when people went through the Korean War during the 1950s. In 1990s, it was issued again under the pressure of WTO system of opening the Korean rice market and of increasing movement of international grain prices.

Korea has the lowest grain self-sufficiency rate among OECD members. In 1996, Korea's self-sufficiency rate of all grains dropped to the lowest rate of 26.4 percent (excluding those for feed use, 52.4 percent) since 1970s. After the 1970s, the self-sufficiency rate of rice, the most important crop in Korea, has been relatively increased at an annual average of 95 percent. It's mainly due to the consistent efforts of Korean government for increasing and maintaining self-sufficiency of rice. The rate has been above 100 percent since 1999 and the inventory level of over-stocked rice is currently at issue in Korea.

For the goal of rice self-sufficiency, the Korean government has focused on the construction of farmland systems, and the investment in agricultural land and water development. Therefore, the main aim of the investment in agricultural land and water development in Korea can be said to "Mobilize Resources to Fight Hunger" one of two themes for the forthcoming ***World Food Summit: five years later*** *(WFS: fyl)*.

The main purpose of this paper is to explain the historical contents of the agricultural land and water development projects in Korea. In addition, this paper will discuss the economic returns and lessons from the projects with the related systems and policy directions.

OVERVIEW OF CURRENT AGRICULTURAL LAND AND WATER DEVELOPMENT PROJECTS

Outline of main projects

Under the WTO system, the government regards "agricultural land and water development projects (investment in land and water)" as the most fundamental way to boost agricultural competitiveness and to maintain self-sufficiency of rice. The MAF (Ministry of Agriculture and Forestry) assigns about 30 percent of the agricultural budget for the agricultural land and water development projects.

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The main projects, among all of the agricultural land and water development projects executed by Korean government, are land consolidation, irrigation water development, upland improvement, on-farm road improvement, drainage improvement, repair of irrigation facilities, large scale area development, and soil improvement project.

Land consolidation

The main purpose of land consolidation is enlarging lot size by collectivizing small lots of arable land which are irregularly scattered around, building irrigation canals and drainage canals, and improving on-farm roads. Land consolidation project is classified into two types: small-scale land consolidation (general type of land consolidation in Korea) and large scale land consolidation.

Small-scale land consolidation is the most general and oldest way of land consolidation in Korea. It aims at constructing the base for rice self-sufficiency by increasing land productivity and reducing labour hours for farming. It is classified into several types by size of lot such as 0.1ha, 0.2ha, 0.3ha, 0.4ha and 0.5ha.

Large-scale land consolidation is a newly adopted policy since 1994 under the changed environment of rice production. Although this policy has same goal, it aims at increasing the efficiency of farming machines use. For this, the size of already consolidated early lots was doubled to its previous size. This change of lot size allows easy access of large farming machines with enlarged farm roads. The minimum lot size of large-scale land consolidation is 1 ha (in 1999, the average farm size per household of the Republic of Korea was 1.37ha, and the average rice paddy field size per household was 1.0ha). This project costs about 25 million won (US$20 000) /ha. The financial source of large-scale land consolidation is special government tax named by "Special Tax Act for Rural Development." This tax has been enforced since 1994 to cope with the pressure of WTO scheme.

In addition to small- and large-scale land consolidation projects, there is a third type of land consolidation. Recently, simple land consolidation is being tested. Its goal is reducing the size of idle land such as unfavourably suited arable land. The cost of this project is generally about one-fifth that of other land consolidation projects. However, it is very difficult to achieve good results.

Irrigation water development

Irrigation water development project is used to increase the utility of agricultural water supply and the percentage of irrigated paddy fields. To this end, reservoirs and pumping stations are built in areas of frequent drought. This project can be categorized into two projects such as "large scale water development" and "small-scale water development."

Large scale water development projects means developing agricultural irrigation facilities in frequent drought areas where the size is more than 50 ha to establish an agricultural basis. Meanwhile, small-scale water development includes small-scale surface water development and water development against drought. The main target of small-scale surface water development is additional facility patch on an irrigation benefited area. On the contrary, the target of water development against drought is partially irrigated paddy fields.

Drainage improvement

The drainage improvement project is for improving surface and ground water drainage. To avoid water flood damages of agricultural products, improving the surface and ground water drainage facilities (such as drainage pumping stations and drainage canals) are playing a key role in agriculture.

Obviously, these projects support additional increasing returns of farmland by making vinyl house agriculture and the like possible.

Repair of irrigation facilities

Repair of irrigation facilities is replacing outdated or inefficient facilities to prevent damage and to save enough agricultural water flow. Dredging reservoirs is included in this project.

Upland improvements

Upland improvement projects help farmers voluntarily respond to the growing demand for upland crops and to strengthen the competitiveness of these crops. This project especially ensures the absolute size of paddy fields. Due to the upland improvement project, farmers don't need to discard their rice planting on paddy field for a high economic return from upland crops. Thus this project could be interpreted as a policy for stabilizing rice production. This project deals with irrigation facility development, on-farm road improvement, upland consolidation and so on.

On-farm road improvement

On-farm road improvement project is related to mechanization trend of agriculture. Improved on-farm road would facilitate an access of various agricultural devices. In addition, this project allows prompt connection between production fields and food processing fields. This project is usually conducted on already consolidated farmland.

Comprehensive land and water development initiated by local autonomy

This project concerns wide variety of agricultural water uses based on locally owned river basin. Under the project, each local river basin is widely upgraded to improve agricultural productivity. In addition, beside of agricultural water uses, this project concerns residential and industrial water uses. Thus, this project includes a lot of various policy issues and specified plans.

Soil improvement

Soil improvement project is executed to increase land productivity and improve quality of product by inputting soil conditioners on acidified arable land. This project needs relatively less cost than other projects.

Recent annual budget of main agricultural land and water development projects

The budget of agricultural land and water development projects increased until 1998 (see Table 1). In 1998, the annual budget of agricultural land and water development projects was about 2 290 billion won (about US$2 billion). However, the total budget has decreased from 1999. During the 1990s, the budget for land consolidation was considerably decreased but the budget for irrigation facilities has been increased continuously since 1994.

TRENDS AND OUTCOMES OF AGRICULTURAL LAND AND WATER DEVELOPMENT PROJECTS

Agricultural land and water development projects have been continuously executed by the Korean government since 1946. These projects have contributed to increase the productivity of arable land. As of the end of 1999, 878 000 ha of paddy field were irrigated and 802 000 ha were consolidated from Korea's total paddy field of 1 153 000 ha (76.2 percent and 69.6 percent of total paddy filed respectively). From 1946 to 1999, slopeland reclamation projects were executed on 189 000 ha and contributed to enlarging uplands to 746 000 ha.

Tables 2 and 3 summarize the executed main agricultural land and water development projects and their cost from 1946 to 1998 (repair of irrigation facilities, surveys and natural disasters are excluded). From Tables 2 and 3 show that irrigation water development projects were the focus until the 1970s while land consolidation projects were emophasized during the 1980s and 1990s.

Trends in Korean agricultural land and water development projects since 1945 are as follows:

The 1950s (1945 to 1959)

Korea experienced social changes such as independence from Japan (1945) and the Korean War (1950-1953). During this period, war and the following baby boom led to a severe food shortage throughout the country. Agricultural land and water development projects succeeded previous irrigation water development projects operated by the Japanese (from about 1910 to 1945).

The 1960s (1960 to 1969)

In 1961 the first "Law of Farmland Improvement" was registered for a new farmland improvement project. During this period, farmland extension projects (such as slopeland reclamation and tideland reclamation) were executed with previous irrigation water development projects for paddy fields.

The cost of farmland extension projects was about 27.1 percent of total farmland improvement project's cost. An annual average of 15 000 ha of new paddy fields were established by these projects during 1960s.

The 1970s (1970 to 1979)

The 1960's economic development movement and following drastic economic growth forced disparity between urban and rural area. A drastic economics growth needed massive labour forces from rural area. Thus, in the agricultural sector, the improved productivity of labour and farmland were desperately needed to substitute for lack of labour power.

In 1970, a new law allows use of foreign funds for the agricultural land and water development projects. With the aid of foreign funds, diversity of agricultural land and water development projects were successfully on the track. During the period, self-sufficiency of rice and rural modernization were achieved. Also, large scale agricultural irrigation water developments for five main river basins were heavily conducted during this period. These figures were mainly came from an availability of foreign funds.

TABLE 1
Annual budget: agricultural land and water development projects (1994-2000) (million won)

	1994	1995	1996	1997	1998	1999	2000
Land consolidation	414 515	513 645	604 290	832 240	744 675	465 889	300 119
Upland improvement	39 660	38 500	158 600	158 600	159 995	124 482	124 482
On-farm road improvement	-	15 060	162 400	162 400	170 560	150 451	155 444
Drainage improvement	63 000	78 000	106 000	154 411	164 500	162 500	218 100
Repair of irrigation facilities	67 816	95 309	142 502	218 354	256 724	224 727	284 762
Irrigation water development (large scale) (small-scale)	152 919 (116 767) (36 152)	231 266 (195 000) (28 648)	279 215 (240 344) (38 871)	390 695 (352 913) (82,482)	525 202 (443 022) (82 180)	351 465 (301 465) (50 000)	360 322 (308 322) (52 000)
Large scale area development	29 000	55 500	63 672	96 000	80 949	73 541	92 500
Comprehensive land and water development	-	-	-	-	1 769	3 592	19 820
Seadyke construction	88 000	98 100	135 038	154 279	88 000	96 000	76 400
Water quality improvement	-	-	-	-	-	940	466
Land and water survey	-	-	529	6 606	7 641	6 834	6 777
Support FIA	120 126	102 056	106 491	111 891	91 682	72 169	64 341
Total	975 036	1 277 436	1 758 208	2 146 476	2 291 697	1 732 590	1 342 711

Note: US$=1 300 Won (1960-1990s: US$=800 ~1 100 Won)
Source: Ministry of Agriculture & Forestry (MAF)

The 1980s (1980 to 1989)

The range of agricultural land and water development projects was widely expanded during 1980s. The huge decreasing of agricultural labour needed a help of mechanized agriculture. This trend enforced land consolidation project as a main part of agricultural land and water development projects. Following the "General Rural Policy" in 1986, the annual cost of projects was more than 100 billion won and over 200 million won in 1989.

The 1990s (1990 to 1998)

This period could be classified as the total crisis of agriculture. Decreasing farmland and self-sufficiency rate in food, unexpected climate change, and the growing pressure for food market opening were main factors of the agricultural crisis. Under the circumstances, several policies were executed to reduce production cost and improve productivity. One policy was "Rural Structure Improvement Policy" in 1992. For this policy, 42 trillion won was scheduled to be spent until 2001. In 1993, the timetable of the policy was reduced to 1998 with different investment lists. A recent policy was "Rural Development Policy" in 1994. This policy constructed agricultural response scheme against WTO system with focusing on improving rural living environment. From this policy, the scope of government was changed.
TABLE 2

Main agricultural land and water development projects executed (ha)

	Total	1945-1949	1950s	1960s	1970s	1980s	1990s
Total	2,041,116	15,756	164,241	594,048	525,953	309,215	431,903
Irrigation water development	898,172	15,520	158,308	337,171	214,648	82,627	89,898
Drainage improvement	73,700				16,526	25,783	31,391
Land consolidation	659,562			95,935	196,972	160,759	205,896
(paddy field)	639,970			95,935	196,972	160,759	186,304
(upland)	19,592			□	□	□	19,592
Large scale area development	179,599				68,707	30,362	80,530
Slopeland reclamation	189,473		2,514	152,833	27,550	4,646	1,930
Tideland reclamation	40,610	236	3,419	8,109	1,550	5,038	22,258

Sources: Ministry of Agriculture & Forestry (MAF), Korea Agricultural & Rural Infrastructure Corporation, Yearbook of Agricultural land and Water Development Statistics.

TABLE 3
Costs of main agricultural land and water development projects (million won)

	Total	1945-1949	1950s	1960s	1970s	1980s	1990s
Total	15,282,070	7	8,501	50,872	613,601	3,118,104	11,490,985
Irrigation water development	4,424,106	6	7,848	27,451	202,418	898,502	3,287,881
Drainage improvement	908,390				10,439	186,419	711,532
Land consolidation	6,761,628			9,662	109,166	969,024	5,677,776
(paddy field)	6,128,162			9,662	109,166	969,024	5,040,310
(upland)	637,466						637,466
Large scale area development	2,001,602				259,158	863,371	879,073
Slopeland reclamation	53,155		44	8,269	23,775	21,067	□
Tideland reclamation	1,129,189	1	609	5,490	8,645	179,721	934,723

Note: US$=1 300 Won (1960-1990s: 1 US$ = 800-1 100 Won)
Source: Ministry of Agriculture & Forestry (MAF), Korea Agricultural & Rural Infrastructure Corporation, Yearbook of Agricultural land and Water Development Statistics, 2000.

COST SCHEME OF AGRICULTURAL LAND AND WATER DEVELOPMENT

The implementation status of agricultural land and water development projects was changed by need of specific periods. The implementation was affected by political and economical support. After the long period of focusing on agricultural irrigation water development, the main goal of agricultural land and water development projects was moved to "Large scale area development project" (1970s), "Farmland consolidation project" (late 1980s), and recent "Upland improvement project" and "Repair of irrigation facilities project."

Until the 1980s, farmers had to pay a certain amount of money to the rural infrastructure improvement projects with specific rates (see Table 4). Thus, rural infrastructure improvement projects have difficulties to complete the project with a full satisfaction of participants. From 1989, all the cost of "Agricultural land and water development projects" was assigned to government subsidy. Due to this surprising change, farmer's cost burden was considerably decreased. However, in some rural area, low level of local government subsidy prevents timely development.

OPERATION AND MAINTENANCE OF IRRIGATION WATER FACILITIES

Local government and the local Farmland Improvement Association (FIA) manages each facility built from agricultural land and water development projects. The responsibility of management is decided by the size of facilities. Usually, FIA manages facilities constructed by Rural Development Corporation (RDC). "Benefited pays principal" was traditionally the main rule to control facilities' administration costs but government subsidized current expenses deficit to relieve farmer's burden since 1987.

As mentioned, continued irrigation water development project improved the ratio of irrigated paddy to 76.2 percent in 1999. FIA administrated irrigation facilities in 58.2 percent of irrigated paddy fields and local government administrated the other irrigated paddy fields being controlled by farmer's autonomy (see Table 5). The 46.2 percent of the latter paddy fields (about 169 000 ha) have Farmland Improvement Clubs (FIC) operated by farmers. Table 6 also shows total irrigated area by irrigation facilities in 1999.

In 2000, FIA, RDC, and Federation of Farmland Improvement Association (FFIA) have merged in Korea Agricultural and Rural Infrastructure Corporation (KARICO). The establishment of KARICO changes methods of agricultural land and water development projects and administrating irrigation facilities. This change of irrigation facilities administration method mainly affected farmer behaviour. Under the scheme of FIA, the participation of farmer was frequently made but farmers' voluntarily activity for administrating irrigation facilities was decreased after the launch of KARICO.

From Table 7, from 1990 to 1996, the average irrigation facility maintenance cost was 35 6000 won/10a to FIA and 3 750 won/10a to FIC. In spite of the high cost of FIA compared to FIC, FIC could charge only average of 5 400 won/10a to facility users. Including government subsidy (average of 18 300 won/10a) with this water charge income, average total FIA income was only 67 percent of its total managerial cost. The farmland improvement association law regulated the amount of water charge, and that water charge compensated only 15 percent of FIA's managerial cost. Government possibly change the amount of water charge considering an inflation and other factors but actually changing water charge is difficult to conduct with a lot of barriers. Furthermore, this situation is going worse than before. In 2000, abolishment of the Farmland Improvement Association Law makes no water charge system for farmer. Thus, KARICO took all the cost burden of irrigation facility administration.

TABLE 4
Government subsidy & total cost of agricultural land & water development projects (%)

	1945-1949	1950s	1960s	1970s	1980s		1990s
					First half	Latter half	
Irrigation water development	50	50	60	70			
- large scale					70	100	100
- small-scale					70	90	100 (30)
- ground water			100	100	100	100	100
Drainage improvement				100	100	100	100
Land consolidation							
- (small-scale)			40	80 (30)	80 (20)	90 (20)	100 (20)
(large scale)							100
- On-farm road improvement							100
- Upland improvement							100 (20)
Conversion to arable land							
- Slopeland reclamation		50	60	60	60	60	0
- Tideland reclamation	50-55	50	80	80	80	100	100
Large scale area development				80	80	100	100
Repair of irrigation facilities							
- Operated by FIA						100	100
- Seadyke					80	100	100

Note: 80 (30) means that 50% is government subsidy, 30% is local government (local autonomy), and 20% is charged to farmers.
Source: Ministry of Agriculture & Forestry (MAF)

OUTCOMES/PROBLEMS OF AGRICULTURAL LAND AND WATER DEVELOPMENT PROJECTS

Positive outcomes from agricultural land and water development projects

Establishment of basis for self-sufficiency of rice

Rapid economic growth and urban expansion has contributed to a falling grain self-sufficiency rate since 1970 with decline of the crop production area. The self-sufficiency rate of all grains dropped from 93.9 percent in 1965 to 29.4 percent in 1999 (excluding those for feed use). The self-sufficiency rate for rice, Korea's most important crop, has been relatively high at an annual average of 95 percent after the 1970s thanks to consistent efforts. The rate has been over 100 percent since 1999 (Table 8).

TABLE 5
Change in irrigated paddy field area (000 ha, %)

	Total paddy field (A)	Irrigated paddy field			Percentage of B/A
		FIA	Non-FIA	Total (B)	
1970	1 284	317	428	745	58.0
1975	1 277	364	426	790	62.0
1980	1 307	424	469	893	68.0
1985	1 325	471	477	948	72.0
1990	1 345	512	475	987	73.4
1995	1 206	504	403	907	75.2
1999	1 153	512	366	878	76.2

Source: Ministry of Agriculture & Forestry (MAF), Korea Agricultural & Rural Infrastructure Corporation, Yearbook of Agricultural land and Water Development Statistics, 2000.

TABLE 6
Irrigated area by irrigation facility (as of the end of 1999) (ha, %)

	Total		Facilities operated by FIA		Facilities operated by Non-FIA (Si and Gun)	
	No. of Facilities	Irrigated area	No. of Facilities	Irrigated area	No. of Facilities	Irrigated area
Total	63 547	814 348	12 025	507 598	51 522	306 750
Reservoirs	17 956	510 969	3 277	370 356	14 679	140 612
Pumps & drain stations	6 398	149 366	3 449	119 697	2 949	29 669
Weirs,	18 320	101 178	3 844	14 277	14 476	86 902
Infiltration Galleries	3 739	19 755	463	3 195	3 276	16 560
Tubewells	17 134	33 079	992	73	16 142	33 007

Note: Out of 10 878 ha project area and area irrigated by other facilities 53 268 ha are excluded.
Source: Ministry of Agriculture & Forestry (MAF), Korea Agricultural & Rural Infrastructure Corporation, Yearbook of Agricultural land and Water Development Statistics, 2000.

A key factor for stable commodity prices in national economy

The economic crisis resulting from the IMF and and WTO system boosted unstable commodity prices in Korea. The stable supply of domestic agricultural commodities contributed to lessening social turmoil and economic stabilization. From 1986 to 1991, annual average agricultural product prices increased about 8.5 percent and its high increasing ratio brought the pressure of inflation. However, since 1992, after massive investment in agricultural land and related development projects, the average price of agricultural products decreased considerably, by 5.5 percent. Table 9 shows the consumer price indexes of selected food items. The consumer indexes of vegetables and fruits show

mostly decreasing figures among other categories. Again, this result was from agricultural land and water development projects.

TABLE 7

	Area commanded by FIA			Area commanded by FIC		
	Cost per 10a (A)	Assessment (B)	B/A×100	Cost per 10a (C)	Assessment (D)	D/C×100
Average	35 600	5 375	15.1	3 750	4 702	125.4
1990	35 800	4 699	13.1	3 740	4 637	124.0
1991	30 500	5 076	16.6	3 530	4 724	133.8
1992	31 800	5 439	17.1	3 910	4 914	125.7
1993	32 800	5 597	17.1	3 810	4 819	126.5
1994	34 500	5 597	16.2	3 810	4 687	123.0
1995	39 900	5 482	13.7	3 760	4 660	123.9
1996	44 300	5 737	13.0	3 700	4 470	120.8

Note: Farmland Improvement Association (FIA) and Farmland Improvement Club (FIC) guided by local autonomy Status of water charge assessed by operator of irrigation facilities (won) (Si and Gun).
Source: Ministry of Agriculture & Forestry (MAF)·Korea Agricultural & Rural Infrastructure Corporation, Yearbook of Agricultural land and Water Development Statistics, 1990-1997.

TABLE 8
Self-sufficiency rate of rice and all grains (%)

	1965	1975	1980	1985	1990	1995	1996	1997	1998	1999
Rice	100.7	94.6	95.1	103.3	108.3	91.4	89.9	105.0	104.5	96.6
All grains	93.9	73.1	56.0	48.4	43.1	29.1	26.4	30.4	31.4	29.4
All grains (excluding feed use)	98.8	79.1	69.6	71.6	70.3	55.7	52.4	58.0	57.6	54.2

Source: Ministry of Agriculture & Forestry (MAF), Major Statistics in Agriculture and Forestry, 2000

Enhancing the efficiency use of agricultural land

The agricultural land and water development projects enhanced efficiency of agricultural land use with introducing mechanization methods. This project also saved labour input and opportunity cost of agricultural production. Thus, finally, this project has achieved low cost production and farmer's positive attitude toward continuous farming.

Table 10 shows the results of a survey conducted by MAF. Following agricultural land and water development projects, rice production has increased about 5 percent, and rice production cost and total farming labour hour reduced 16.2 percent and 33.4 percent respectively. After drainage improvement projects, total agricultural field production increased by about 23 percent.

TABLE 9
Changes in Price Index

	`86	`91	`92	`95	`96	`98	rate of rise(%)			
							`86-'91	`92-'95	`96-'98	`92-'98
Total commodities	58.4	80.9	86.0	100.0	104.9	117.8	6.7	5.1	6.0	5.4
Foods	53.4	80.3	85.2	100.0	103.9	117.3	8.5	5.5	6.2	5.5
Grains	64.1	85.6	88.3	100.0	115.7	128.5	5.9	4.2	5.4	6.4
Meat	62.9	98.7	98.4	100.0	98.8	100.9	9.4	0.5	1.1	0.4
Vegetables	44.1	75.6	78.5	100.0	104.2	120.3	11.4	8.4	7.4	7.4
Fruits	37.2	77.8	81.6	100.0	86.3	99.6	15.9	7.0	7.4	3.4
Others	61.5	81.3	86.3	100.0	105.4	118.1	5.7	5.0	5.8	5.4

Source: Ministry of Agriculture & Forestry (MAF)

Preventing the spread of idle land

Due to the limited available arable land for Korea's dense population, government needs slopeland reclamation and tideland reclamation for arable land expansion. It also exerted all possible efforts to prevent the spread of idle land. According to an MAF survey, the main reason for converting paddy field into idle land was unfavourable farming conditions for the farmer. Thus, MAF regards land and water improvement projects as the most influential means to prevent spread of idle land.

Problems in agricultural land and water development projects

Mood of avoidance to investment in agricultural land and water development

Financial experts and government officers argue that government should cut down its expenditure on agriculture, especially on land and water development budget, to put emphasis on the efficient investment. With respect to this opinion, government tends to put less weight on agricultural land and water development projects. It is easily shown that current agricultural investment project more emphasize on agricultural marketing improvement projects than agricultural land and water development projects.

Each time period has different goals to achieve from agricultural investment. Until the early 1980s, agricultural investment emphasized that the improvement of productivity, while more recently reducing production cost with reduced labour has been the focus. However, recent agricultural land and water development projects face the limit of maximized outcome.

TABLE 10
Economic returns from land consolidation: rice production (%)

	Japan	Korea
Land productivity Increase effect	5.7 □	5.0 □
Production Cost down effect	19.9 □	16.2 □
Labour hours reduction effect	31.8 □	33.4 □

Source : Ministry of Agriculture & Forestry (MAF)

Lack of matching funds from local autonomy

The launch of local autonomy by the previous central government provokes urgent need for locally focused investment projects with locally planned policies. However, most local government faces difficulty in conducting such projects with limited funds.

For land consolidation projects, the central government is supposed to support 80 percent of the project cost while local government pays 20 percent. In spite of original cost schedule, local government paid more than 20 percent and this figure has been gradually increased in each year (26 percent in 1996, 29 percent in 1997, 32 percent in 1997, 36 percent in 1999, and 38 percent in 2000). This increasing cost burden of local government forced to reduce size of land consolidation project. Thus, unbalanced development and low level achievement is expected in some local areas.

Manpower problem for irrigation facilities operation and maintenance

KARICO was intended to attain economy of scale, reduce farmer debt, and operate rationally. However, initiation of KARICO faced difficulty in proper operation of its irrigation facilities due to a 30 percent reduction of irrigation facility workers. KARICO also faced the problem of falling voluntarily participation by farmers in maintaining canals and drainage. The economics free riding problems were evolved in use of irrigated water.

POLICY DIRECTIONS

Basic policy directions

Some observations made be may regarding basic policy directions:

- because of financing difficulty, government must increase the efficiency of investment in land and water development;
- it is time to change the agricultural policy goal from quantity- to quality-focused;
- it is necessary to introduce environmentally friendly methods of development;
- the operation and maintenance of exiting irrigation facilities should be emphasized more than development of new water irrigation facilities;
- Removing the entry barriers of private construction companies to enter the agricultural land and water development project to allow competition between constructors.

Current issues and policy directions

Secure stable project funds

Agricultural land and water development projects need long term investment to attain desirable outcomes. To this end, securing sufficient, stable funding is very important.

Apposite project schedule and cost actualization

The goal of the project should be fully considered subject to available funding. Also, government realizes the geographical differences of each area and actualizes the cost for development project.

An alternative policy for reducing project cost

An alternative policy is needed to reduce the cost of development projects. For example, alternative projects such as on-farm road construction and exiting irrigation canal improvement project could be selected in specific area instead of large scale development projects to get a partial improvement. In addition, several projects may be bundled (packaged) to reduce additional costs under the long term plan. Introducing advanced techniques and methods could reduce project cost. To this end, developing new methods and technology is very important.

Improving system management methods

Agricultural irrigation water development project has focused on installing new facilities or upgrading exiting facilities. However, the capacity for drought and efficiency were continuously doubted. To reduce this uncertainty, irrigation water management systems should be changed to integrate existing small facility capacity with revised management. Also, it is necessary to put more emphasis on repairing and maintaining existing irrigation facilities.

Developing and maintaining information

Most previous development information was not systematically nor continuously managed. From the 1960s, government conducted many national surveys. However, the information from such surveys was not used for other purposes but forgotten. A more systematic approach to exiting data should be conducted to increase its capacity. This procedure could reduce additional cost for time and labour.

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Land and water sector development in Sri Lanka

WATER SECTOR DEVELOPMENT

Historical perspective

Sri Lanka has one of the world's oldest civilizations based on water sector development, beginning over 2000 years ago. The ancient kings build hundreds of major reservoirs and thousands of minor reservoirs to harvest rain water and conserve water for agriculture development. Most reservoirs were located in the country's north central, northwest and northeastern dry zone regions.

Nearly 700 years ago the seat of the kingdom shifted to the central hill country because of varied foreign invasions and a malaria epidemic that let the impressive water tank systems fall into abandonment and disrepair. Restoration work on some tanks began during British rule. Restoration of the major Kalawewa reservoir with a capacity of nearly 145 million m^3 was done from 1885 to 1887. Restoration work on our ancient tank systems was accelerated after independence from British rule in 1948.

Traditionally irrigation water was used to grow rice. Introduction of improved varieties accompanied by the provision of irrigation facilities helped to increase rice production since 1950. It is also observed that the average yield of rice in major irrigation schemes was far above the rainfed rice cultivation.

Large areas of well-drained land on the upper slopes of the catena became irrigable after this new development work. The lands were found to be more suitable for upland crops than rice cultivation due to high rates of infiltration and poor retention of water for flooding. Due to additional irrigation facilities available and better markets established the country showed a dramatic increase in production of other crops during the period 1970 to 1988. The import restrictions imposed on these commodities helped farmers get a good price for their products. With the liberalization of trade policies in the 1980s, there was a downward trend in OFC production but rice remained a major source of income for the farmers.

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Irrigation systems management

Irrigation systems commanding more than 80 ha categorized as medium or major reservoirs (80 ha-40 000 ha) are constructed, operated and maintained by the Irrigation Department (Table 1). There are more than 300 major irrigation systems in operation at present. Several selected major irrigation systems (Table 2) are managed jointly by the Irrigation Department and the Irrigation Management Division (IMD) of the Ministry of Irrigation under the Integrated Management of Major Irrigation Settlement Schemes (INMAS) programme. Minor irrigation systems (irrigation systems commanding less than 80 ha) are constructed or renovated by the Irrigation Department but managed by the Agrarian Services Department.

According to an FAO estimate there are 7 758 village tanks. The Freedom from Hunger Campaign estimates 18 000 village tanks. Another source reports some 12 000 tanks in abandoned state while 8 500 working tanks are functioning in the dry zone. Altogether there are about 600 000 ha of irrigable land in the country under different categories: Irrigation Department. 294 640 ha of major irrigation; Mahaweli Economic Agency, 115 960 ha of major irrigation; Agrarian Services Department, minor irrigation areas of 180 000 ha. Also, see Tables 1 and 2.

Table 1
Irrigation systems under the Irrigation Department

Size of systems (ha)	Number of systems	Total area (ha)
80 to 600	223	41 480
600 to 1 000	27	19 160
1 000 to 1 200	29	40 320
1 200 to 4 000	23	61 680
Over 4 000	13	132 000
Total	315	294 640

Source: Perera, K.D.P. (1986).

Table 2
Mahaweli Economic Agency irrigation systems

System	Irrigated area (ha)		Net irrigable area full development
	87/88 Maha	88 Yala	
System "H"	24 954	17 056	25 240
System "G"	4 171	3 917	3 327
System "B"	8 655	8 192	47 414
Walawe	12 451	10 887	55 320
System "C"	13 579	8 539	22 243
Total	63 810	48 591	115 960

Source: Mahaweli Engineering and Construction Agency, Structure Plan/MEA Statistical Division, Mahaweli Statistical Annual (Files 1988).

Farmer participation in irrigation management

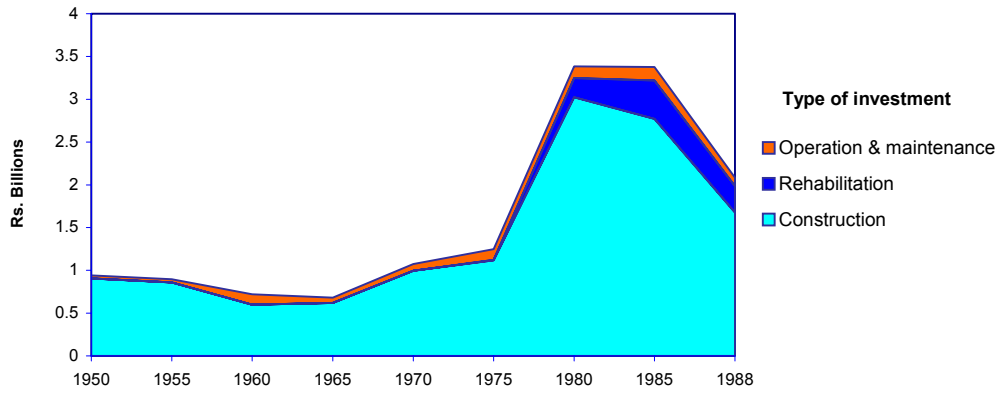
In major irrigation systems field level irrigation management is done through irrigation engineers, technical assistants, work supervisors and irrigation labourers. A technical assistant is responsible for about 2 000 ha, while work supervisors and irrigation labourers are responsible for 1 000 ha and 200 ha respectively. Water distribution and allocation is determined by the farmers at the seasonal (kanna) farmers' meeting scheduled prior to every cultivation season at which officers and farmers collectively take decisions on water distribution and cultivation. In IMD schemes management of field channels is given to farmer organizations. They are allowed to collect operation and maintenance (O&M) taxes and carry out maintenance themselves. Technical officers provide necessary support. The programme is now being implemented as a pilot programme and shown some success so far.

Cost of irrigation systems

Most large-scale irrigation infrastructure development is associated with power generation. Sri Lanka has an installed capacity to generate 1 135 MW of electricity through a hydropower network of 16 hydropower stations. The water resources still available for further exploitation is diminishing and becoming more expensive. Thermal energy is now being pursued. However, there is high potential to develop rural electric generation plants making use of small stream flows and the available steep gradients.

Investment in several major irrigation works – new construction, rehabilitation and operation

FIGURE 1 Changes in irrigation investments in Sri Lanka, five-year moving averages, 1950-1986 (1986 prices)



and maintenance from 1950 to 1988 – is given in Table 3 and Figure 1. Another estimate of the cost of rehabilitation is given in Table 4. The capital cost of some new irrigation systems is given in Table 5. The cost of providing irrigation water to the Mahaweli area, for example, is estimated at nearly US$14 000 to 25 000 per/ha. The development cost of small to medium irrigation works is relatively low compared to Mahaweli but still is considerable. However, this amount will fall when the benefits derived from power generation are deducted. Government investment from 1988 to 1992 on capital expenditure is given in Table 6. Investment for irrigation increased tremendously during the last 40 years, rising to 30 percent of public investment in 1983. From 1988 to 1992, a significant investment was made in irrigation infrastructure development. This is mainly because of the accelerated Mahaweli Development Programme. Investment in irrigation other than the Mahaweli Programme decreased by 70 percent from a high figure of Rs. 1.322 billion in 1989 to Rs. 390 million in 1992

(Table 6). Since then it has shown a downward trend but remains a significant component of government investment. At present investment in irrigation is about 10 percent of public investment.

Table 7 shows investment in village irrigation schemes from 1950 to 1982. Irrigation investment in the Public Investment Programme (PIP) is given in Table 9. Its data was reported in a study made by the IMMI, Sri Lanka, titled *"Irrigation Investment Trends in Sri Lanka: New Construction and Beyond"* from various information sources.

Current cost of irrigation development

Details of one project likely to be approved for implementation (now in planning) is given below to demonstrate current level of water sector development investment. The "Potential Rehabilitation of Irrigated Agriculture in the Dry and Intermediate Zones of Sri Lanka" (Main Report 2000, Nippon Koei, JICA and the Ministry of Irrigation and Power).

TABLE 3
Irrigation investment by type, government budget, total public investment, 1950-1988*

IRRIGATION INVESTMENT (Rs. million)					Share of total irrigation investment (%) in	
	New Construction[1]	Rehabilitation[2]	Operation & Maintenance[3]	Total	Government budget	Total public investment
1950	907 (96)	-	34 (4)	941 (100)	8	47
1955	859 (96)	-	38 (4)	897 (100)	6	29
1960	601 (83)	-	121 (17)	722 (100)	3	19
1965	619 (91)	-	62 (9)	681 (100)	3	15
1970	994 (93)	-	78 (7)	1 072 (100)	3	16
1975	1 116 (89)	5 (1)	127 (10)	1 248 (100)	2	13
1980	3 023 (89)	225 (7)	137 (4)	3 385 (100)	6	21
1985	2 270 (82)	451 (13)	154 (5)	3 375 (100)	6	18
1988	1 676 (80)	308 (15)	102 (5)	2 086 (100)	3	NA

NOTE: (1) Five-year averages centring on years shown, except 1988, indicated in 1988 prices. Figures in parentheses are percentages; (2) Investment for constructing new systems or restoring abandoned old systems; (3) Major rehabilitation and modernization of existing systems. NA = not available.

The proposed project is still in planning and is envisaged to rehabilitate eight major reservoir schemes, eight medium reservoir schemes and 80 minor schemes comprising 18 200 ha and 25 300

farm households. The goal of the project is to improve agricultural productivity, farm income, irrigation facilities, farm roads and farming systems. The project is estimated to cost nearly Rs. 2667 million (US$37 million at US$1= Rs.71). The area of the eight major schemes is 14 167 ha, eight medium schemes at 1 519 ha and the area under minor schemes is 2 509. The estimated cost of development is US$1 370, US$1 070 and US$620 respectively, for major, medium and minor schemes. The project is expected to be implemented by the Irrigation Management Division of the Ministry of Irrigation and Power.

TABLE 4
Cost of Rehabilitation (1987 prices)

Size of system	Rs/ha	US$/ha
Large	31 290	1 063
Medium	21 335	725
Small	14 225	483

SOURCE: Ministry of Lands and Land Development.

Recovery of irrigation costs from farmers

In ancient Sri Lanka farmers paid for water received in labour services called *Rajakariya*. Farmers were obliged to work for the king in return for the services received to cultivate his land. The services mainly covered the supply of land and water.

TABLE 5
Capital cost of irrigation systems (1987 prices)

System	Rs./ha	US$/ha
Mahaweli	426 500 - 711 150*	14 490 -24 150
Kirindi Oya	284 450*	9 660
Nagadeepa Project	1 217	
Puburattewa Project	5 636***	
Tank Irrigation Modification	51 080**	
Kibulwanana Project	4 332***	
Inginimitiya	125 200*	4 250
Medium-scale projects	36 950*	1 255
Small-scale projects (VIRP)	22 800*	775

SOURCE: (*) Ministry of Lands and Land Development; (**) irrigation Department; (***) Atukorala & Atukorala (1990)

The British who ruled after 1815 did away with the traditional *Rajakariya* system. After some years, having realized the importance of the ancient system, they reintroduced it and imposed six days of annual compulsory labour for repair and upkeep of roads and irrigation works. Irrigation Ordinance No. 21 of 1867 introduced an irrigation rate to recover the cost of improving irrigation facilities. In 1984 an attempt was made to recover part of the cost – calculated as Rs. 500/ha of irrigation – from farmers who were initially were asked to pay Rs. 250/ha. It was proposed to increase the rate annually by Rs. 50/ha as it was found that the O&M fee collection was unsatisfactory.

Maintenance of large irrigation projects was a responsibility of the government using loans and funds out of national budget. Registered farmer Organizations could obtain contracts for O&M up to maximum of Rs. 250,000/-. The O&M budget has the component funds coming from State and funds from farmer contributions. It was estimated that the cost of O&M could be met with 3-9 percent of benefits derived of irrigation.

MAJOR WATER SECTOR PROGRAMMES

Mahaweli Ganga Development Programme

The Mahaweli Ganga Development Programme was implemented directly under the Ministry of Mahaweli Development. It was planned to irrigate nearly 100 000 ha of new land and about 75 000 ha of already developed land. Five dams have been constructed as regulatory reservoirs with power generation capacity of 540 megawatts. Originally managed by the Mahaweli Development Board (MDB), since 1979 management responsibility was been with the Mahaweli Economic Agency (MEA) under the Mahaweli Authority of Sri Lanka (MASL).

TABLE 6
Government capital expenditure 1988-1992

	1988	1989	1990	1991	1992	Total
	Rs. Million					
Total	**31 764**	**36 739**	**35 146**	**31 932**	**23 764**	**159 346**
Agriculture	8 997	9 317	8 617	8 641	5 119	40 691
Mahaweli	5 050	4 320	4 323	5 015	3 092	21 800
Other irrigation	1 119	1 322	1 092	1 201	390	5 124
Percentage of total						
Agriculture	28.3	25.4	24.5	27.1	21.5	25.5
Mahaweli	15.9	11.8	12.3	15.7	13.0	13.7
Other irrigation	3.5	3.6	3.1	3.8	1.6	3.2
Percentage of agriculture						
Mahaweli	56.1	46.4	50.2	58.0	60.4	53.6
Other irrigation	12.4	14.2	12.7	13.9	7.6	12.6

Source: National Planning Division (1988).

Several irrigation systems were included in the project, each subdivided into projects of 8 000 to 10 000 ha supervised by a resident project manager. Project managers are assisted by several deputy project managers. Projects are divided into blocks of 2 000 to 2 500 ha supervised by a block manager supported by several unit managers supervising 200-250 ha.

The cost of the Mahaweli Development Project was estimated at Rs. 25 billion (US$1.04 billion) compared to all other irrigation work at Rs.3.6 billion or US$128.6 million (Economic Review, 1986:3). The cost of providing irrigation water to Mahaweli Project area was Rs. 100 000/ha

or US$1 775/ha (Economic Review, February 2001).

Anuradhapura Dry zone Development Project (ADZAP)

ADZAP was implemented in Anuradhapura district Sri Lanka's dry zone of Sri Lanka. Financial and technical assistance were provided by the ADB, IFAD and the Government of Sri Lanka. The project was implemented from 1981 to 1988 at a total cost estimated at Rs. 690 million (US$24 million). It focused on rehabilitating minor tanks and developing adjacent uplands, agricultural infrastructure, livestock and support services. The major objectives of the project were to increase food production and productivity, employment, improved rural income generation by optimum use and development of available resources and also to ensure equitable land and water distribution. It also aimed at improving farming systems, including integrated agriculture. About 200 minor tanks were restored, covering nearly 3 000 ha of irrigable land and about 14 000 ha of rainfed land.

Sustainability and lessons learned

A study conducted by Jayasena (1988) reported that project objectives were partially achieved. Integrated agriculture goals in the highlands did not occur, as most farmers did not live in the newly allocated lands. Limited fodder and dry season water could not sustain livestock. Shifting cultivation was eliminated and road networks were improved as lasting positive achievements, but lowland and upland development did not meet expectations. The project evaluation recommended closer cooperation and more careful planning by involved agencies in future projects. The scheme had no proper project evaluation system. Some rehabilitated tanks did not meet minimum criteria and beneficiaries were not selected systematically. Some outsiders gained land and used it improperly and there was no proper water management to make the best use of available water. Also, the project did not distribute good milk cows to the beneficiaries and failed to achieve a proper fodder development programme.

Village Irrigation Rehabilitation Project (VIRP)

A World Bank loan funded the Village Irrigation Rehabilitation Project (VIRP) covering rehabilitation of 1 200 village tanks and modernization of another 500 small tanks in 14 administrative districts. Implemented between 1980 and 1989 at a total cost of Rs.784 million or US$28 million (World Bank, 1981) at an estimated cost of Rs. 12 350 (US$441) per/ha at 1980 prices. Cost of new development was Rs. 24 700/ha (US 880/ha). The estimate for 1980 was increased to Rs.21 600 (US$771) and Rs.43 225 (US$1 554), respectively in 1987.

Benefits and lessons learned

In terms of encouraging farmer involvement in the rehabilitation and management process VIRP was not successful. However, a study conducted by the Agrarian Research and Training Institute (ARTI) has shown 63 percent of farmers reporting improved water supply after rehabilitation. It also reported that channel damaging and illegal water supply have declined significantly after implementation.

Tank Irrigation Modernization Project (TIMP)

The first major irrigation rehabilitation project in contemporary Sri Lanka, this project aimed at rehabilitating five major tanks: Mahawilachchiya (1 053 ha), Mahakanadarawa 2 429 ha), Padaviya (5 061 ha), Pawattakulam (1 781 ha) and Vavunikulam (2 429 ha). The project objective was to increase cropping intensity through timely cultivation with proper allocation and distribution of water. The project began in 1976 and was completed in 1984. It has given more emphasis to engineering

aspects and less attention to institutions and agricultural extension. Its total cost in 1986 prices was Rs. 651 million (US$23 million).

TABLE 7
Capital expenditure in village (minor) irrigation schemes

Period	Amount (Rs. million)
1950-1954	16.4
1955-1959	11.0
1960-1964	6.4
1965-1969	23.3
1070-1974	70.4
1975-1979	196.0
1980-1982	285.00

Benefits and lessons learned

No definite increases to cropping intensity and rice yields were observed though it was an objective (Abeysekera, 1984). Despite improved water conditions, no systematic cropping intensity was observed by Murray, Rust and Rao (1987). The simultaneous rehabilitation of the minor tanks in the watershed area of Mahakanadarawa tank contributed to poor water availability and consequent low cropping intensity. Some of lessons learned included the need for advance planning of works, which prevented improvement of minor tanks above the catchment area. The project ought to have given more emphasis to agricultural extension and institutional strengthening.

Major Irrigation Rehabilitation Project (MIRP)

MIRP represented a continuation of the programme commenced under TIMP. Funded by USAID and IDA loans, the project aimed at improving irrigation facilities and improving agricultural production in seven major irrigation systems in the dry zone. It also aimed to introduce integrated management through rehabilitation and farmer involvement. The project dropped implementation of three systems due to civil strife in the vicinity. Overall project cost to rehabilitate the Nachchaduwa, Huruluwewa, Rajangana and Kantalai irrigation systems was nearly US$39 million. The programme also funded the Integrated Management of Major Irrigation Systems (INMAS) to ensure proper O&M of the irrigation systems and complementary programming of agricultural activities and inputs.

The project objectives have been partially achieved according to the Project Completion Report (PCR), 1994. Rehabilitation works have been carried out as planned and the INMAS concept has been made operational. It appears to have obtained nearly 80 percent of its expected paddy production of 32 400 tonnes, but its programme to popularize growing other crops ended with limited success due to farmers preference to grow paddy and the lack of extension support and credit.

Sustainability and lessons learned

The attempted operation and maintenance of irrigation systems by farmers exhibited limited success and requires technical assistance from trained ID staff. For proper O&M sustainability, farmers need to derive higher income from farming so that they could pay for maintenance. It can be achieved only if they diversify the cropping to get other field crops in their well-drained land.

TABLE 8
Operation and maintenance expenditure, irrigation management division 1987

Range	Irrigable area (ha)	Operation cost	Maintenance cost		Total O&M	O&M cost /ha
			Labour	Material		
Ampara	50 113	2 241 178	6 451 587	495 254	9 187 999	183
Anuradhapura	20 552	1 457 523	2 838 018	350 268	4 645 809	226
Batticaloa	25 921	885 146	4 346 302	11 127	5 242 575	202
Bandarawela	8 322	1 157 827	1 517 990	18 459	2 694 276	324
Colombo	5 889	181 835	857506	195 132	1 234 523	210
Galle	3 898	271 000	510 721	4 261	785 982	202
Hambantota	15 592	1 334 789	2 262 221	343 946	3 940 956	253
Kandy	6 139	676 251	774 962	212 298	1 663 511	271
Kekirawa	11 427	1 587 713	1 093 506	382 460	3 083 679	268
Kurunegala	10 472	1 962 420	792 234	128 790	2 883 444	275
Kilinochchi	21 895	1 320 157	2 420 770	356 381	4 097 308	187
Moneragala	5 820	674 644	1 108 615	202 306	1 985 565	341
Polonnaruwa	24 813	217 036	3 248 781	391 794	3 857 611	155
Puttalam	6 837	758 282	1 474 115	21 000	2 253 397	330
Trincomalee	21 750	158 100 [1]	36 556 [1]	-	194 656	9
Vavuniya	5 096	1 396 152	2 347 368	26 923	3 770 443	740
Total	244 536	16 063053	32 131 252	2 825 229	51 019 534	209[2]

NOTE 1: Expenses were very low due to ethnic troubles.
NOTE 2: If Trincomalee is omitted, the average cost/ha is Rs. 228
SOURCE: Irrigation Management Division, Ministry of Irrigation and Power.

The project learned an innovative concept of integrated management of irrigation systems (INMAS). Farmer organizations showed interest in managing their own irrigation systems. It was learned that organizing farmers for O&M is a slow process. Therefore, adequate long-term programmes should be introduced with built in financial and institutional capacity. The lack of attention given to agricultural extension was a good reason for not achieving targets of OFC. It is also clear that farmers alone cannot do O&M of irrigation systems. Farmers' organizations undertaking construction activities is a good concept.

LAND SECTOR DEVELOPMENT

Historical perspective

With the increasing land-man ratio the competition for land became quite acute during past 100 to 120 years. Due to this, the vast extent of forest that was formerly in existence was depleted, from a high of 88 percent in 1884 to less than 20 percent today. Loss of forest cover and encroachment of state land by the landless has led to an accelerated rate of land degradation by water erosion. Slash and burn cultivation is widespread in Sri Lanka's dry and intermediate zones. Land degradation has been a contributing factor for poverty and unemployment and a threat to food security. In order to mitigate land degradation and combat poverty country has launched several land sector development programmes.

TABLE 9
Irrigation investment in the Public Investment Programme (PIP)

	1978	1979	1980	1981	1982	1983	1984	1985	1986
	Rs. Million at current prices								
Total PIP	5 449	7 809	12 044	11 765	16 056	16 708	19 521	23 633	27 589
Irrigation									
Mahaweli	279	823	1 879	2 218	4 100	4 260	NA	NA	NA
Other	68	307	489	508	632	895	798	1 043	949
Total irrigation	347	1 130	2 368	2 726	4 732	5 155	NA	NA	NA
As percentage of total Public Investment Programme									
Irrigation									
Mahaweli	5.1	10.5	15.6	18.9	25.5	25.5	NA	NA	NA
Other	1.2	3.9	4.1	4.3	3.9	4.6	4.1	4.4	3.4
Total irrigation	6.3	14.4	19.7	23.2	29.4	30.1	NA	NA	NA

SOURCE: Central Bank of Sri Lanka. Review of the Economy (various years).

There has been extensive national planning of sectoral programmes for land and watershed management. Watershed management is a prominent issue in the National Environment Action Plan (NEAP) of 1992-1996 and 1997-2001.These five-year plans are based on national priorities and on an assessment of resources availability. Components of the plan are incorporated into action plans of the implementing agencies responsible for various sectors covered.

MAJOR LAND SECTOR PROGRAMMES

Upper Watershed Management Project (UWMP)

Funded by a loan from the Asian Development Bank and government counterpart funds, the ADB foreign exchange component was US$4.9 million and the local currency component was US$11.7 million. Sri Lanka's contribution in local currency was US$6 million with additional beneficiary contribution of US$1.1 million. The total bank loan contribution was US$16.73 million (Rs. 1 223

million) and local component US$28.20 million (Rs. 2 144 million). The loan was effective from 1998 and last till 2005. The Ministry of Forestry and Environment will have overall responsibility for project implementation.

TABLE 10
Investment in land sector projects

Project	Foreign component	Local component	Loan/grant organization
UWMP	US$ 16.6 million	US$28.2 million	ADB LOAN
UMWMP	10 million DM	-	GTZ Technical Assistance
FORLUMP	2 million pounds Sterling	-	ODA Technical Assistance
LUPPP	NA	NA	ADB
EA1P	US$ 17 million	NA	WB/IDA
SCOR	US$7 million	-	USAID

Source: Project documents

TABLE 11
Public investment in environment related programmes

	PIP %	GDP %
1996 (actual)	12	1.2
1996 desired level	20	2.0

Source: NEAP 1998-2001

The objective of the project was sustainable management of critical watersheds, improve income of project beneficiaries and also to facilitate to develop a watershed management policy. The main concerns of the project are soil conservation, off farm conservation, establishment of peak wilderness buffer zones, sanctuary management and forest management. It also consists of training of farmers and institutional strengthening component.

The project covers three watersheds: the Uma Oya, the Upper Kalu Ganga and the Udawalawe basins. Originally planned to protect 4 500 ha, the Uma Oya basin was expanded to establish forest plantations in the upper Udawalawe watersheds and peak wilderness buffer zones in the upper Kalu Ganga area. In the Uma Oya basin, 4 500 ha will be protected and increased overall crop production on farmlands is targeted. These interventions will help to reduce the rate of sedimentation in reservoirs and will benefit 40 000 farm families and sanctuary conservation of 22 000 ha.

Upper Mahaweli Watershed Management Project (UMWP)

The Mahaweli Authority of Sri Lanka (MASL) implemented the UMWP with financial aid from GTZ for soil conservation and watershed management of the Upper Mahaweli watershed in coordination with other implementing agencies. Activities included promotion of SALT technology, sericulture, drafting conservation plans and promoting mixed farming of crops and livestock.

The introduction of vetiver and SALT appear to be successful in some areas. Due to poor maintenance of hedgerows many are also in neglected state. The project managed to distribute considerable planting material to large number of users and there is potential to promote vetiver in other areas if there is national-level interest.

TABLE 12
Capital expenditure of the Forest Department

Programme Title	Actual 1992 Rs. Million	Estimated 1994 Rs. Million
Rehabilitation of capital assets	7.6	6
Management of protected areas	3.6	2
Participatory Forestry Project		72
Forestry Extension	6	4
Management & orotection of forest resources	2.1	7
Forestry research	2	7
Reforestation and development	0.7	
Total capital expenditure	22	93
Total recurrent	53	73

Source: Forest Department

Forest Land Use Mapping Project (FORLUMP)

Implemented by the Mahaweli Authority of Sri Lanka, the Forest Land Use Mapping Project (FORLUMP) included a TA from ODA and was promoting sustainable management of the Upper Mahaweli Watershed. Its goal was to integrate watershed conservation with development activities. Land use and vegetation studies and mapping of forest areas in the upper Mahaweli watershed areas in the country using GIS technology and satellite imagery. It developed a comprehensive database including 1:10 000 scale land use maps, slope maps, erosivity and erosion hazards.

ADB funded Land Use Planning Project

Funded by the ADB to strengthen the capacity of the Land Use Policy Planning Division (LUPPD). The Land Use Planning Project is to assist carrying out its functions and land use planning in the districts.

Environment Action 1 Project (EAIP)

Initiated in 1996 with World Bank/IDA loan assistance, the Environment Action 1 Project (EA1P) was implemented by the Ministry of Forestry and Environment. Of its US$17 million investment, only US$2.37 million was allocated for the land component while the balance was for infrastructure development and Ministry of Environment and Environment Authority human resources development. The provincial council of the central province, with active participation of various other government organizations, implemented the land component. The secretary of the Ministry of Environment chairs the land component steering committee while the Chief Secretary of the province chairs the provincial steering committee. A technical committee advises on implementation of technical activities. Micro Catchment (MC) is the centrepiece of the organization structure and a microcatchment planning team headed by the area divisional secretary. An MC catalyst officer assists in organizing the farmers.

Ten pilot test sites (later reduced to nine) – ranging from 5 000 to 7 000 ha with varying gradients, rainfall and soil conditions – were selected to implement appropriate technology and treatments/farming system models. Project implementation is through an interactive planning process, in which implementing agencies work together with villagers to prepare and implement development and cropping plans.

Shared Control of Natural Resources Project (SCOR)

Shared Control of Natural Resources (SCOR) was implemented as a component of the Natural Resources and Environment Policy Project (NAREPP) funded by USAID. It was estimated to cost nearly US$7 million. The project target was US$6.5 million of USAID and US$0.5 million user grants plus a country contribution of US$0.15 million. The project began in 1994 and terminated in 1999. Implemented by the Ministry of Irrigation, Power and Energy, the participatory action research project aimed to develop and test holistic interdisciplinary approaches to integrating environmental and conservation concerns with production goals in the watershed context. The SCOR approach was tested in two pilot projects, Huruluwewa in North Central Province and Nilwala in the Southern Province. SCOR strategy was based on farmers' capacity to organize to obtain the benefit of natural resources equitably for both production and protection by implementing a selected package of practices. The SCOR strategy is based on understanding of hydrological, socio-economic and other interactions between different segments of the watershed, experience in group economics and natural resources management and tenurial security.

During its implementation the programme showed some improvement regarding farmers' management of natural resources to improve their livelihoods, but the programme failed to expand beyond its geographic limits and failed to sustain project impacts even within the project area. The concept of farmer companies introduced by the project has gained momentum in some ISMP areas. The failure of the project interventions to survive in the project area or to spread to other areas was attributed to the high level technical assistance provided, unrealistic under the normal management.

Reforestation and Watershed Management Project

Implemented by the Forest Department (FD), with USAID financial assistance, the project objective was to develop the FD institutional capacity to undertake watershed management in hilly regions and enhance timber and fuel wood production. Under this programme, the FD restored 10 000 ha of degraded land in the Upper Mahaweli Watershed. The project also covered forestry extension, forestry research, training and fire protection.

FAO Watershed Management Project

Implemented by the Department of Agriculture with the FAO assistance, the Watershed Management Project began in 1975. Several pilot study sites were used to evaluate the degree of soil erosion. The project also helped to develop human resources of the Soil and Water Research Division of the Department of Agriculture.

Private Investment in Land and Water Development

Private sector investment in water sector development is rare. Several programmes commenced in the Mahaweli System C area during the last three or four years for large scale investment in drip irrigation using Mahaweli water to grow bananas, papaws and coconuts. These programmes covered an area of about 500 ha.

Private investment in land improvement is significant in private sector tea, rubber and coconut plantations, in large plantations as well as smallholder tea and rubber plantations. Though government provides some subsidy for soil conservation, the major share of expenditures is met by the landowners themselves.

The Ceylon Tobacco Company (CTC) conducted the only significant involvement in land sector development in a project in hill country tobacco growing areas. Originally the company gave financial assistance to contract growers to establish stone walls for soil conservation. With the introduction of the Sloping Agricultural Land Technology (SALT) about 10 years ago CTC launched a campaign to introduce SALT technology in the Uma Oya catchment and other major hill country tobacco growing areas. The company reported introducing more than 1 000 ha to the system.

A condition for the contract growers to establish SALT before tobacco planting was that the majority of farmers must adopt the system. However, due to various reasons only a few farmers established and maintained the SALT system properly and their effectiveness as soil conservation measures was unsatisfactory on many occasions due to the poor maintenance of SALT hedgerows.

RECOMMENDATIONS

Water sector

Investment for medium and minor irrigation could be more effective in achieving poverty alleviation and food security than investment for major irrigation projects. The cost of investment per unit area is much high in major irrigation projects than in minor irrigation systems. This factor cannot be ignored in decision making on water sector investment. There is an appreciable change in investment policy on irrigation. The investment in major and new projects is decreasing and rehabilitation costs have reached 25 percent in recent times.

Farmer organizations often are not properly established or effectively organized to manage irrigation systems. Transferring irrigation systems management to farmers must be done more systematically and will need to be done slowly. The farmers alone cannot satisfactorily manage irrigation systems: continuous technical support from irrigation staff is necessary.

Contracting maintenance works to farmer organizations has shown promising results. Hence, it should be further pursued.

The farmer company concept has shown some promising results, which must be strengthened in future programmes.

There is a need for state intervention in rehabilitation of village irrigation systems. Selection of tanks for rehabilitation must be through a proper watershed and water balance study. Furthermore, there is a need to have farmer involvement in decision-making and implementation.

Village community capacity must be fully exploited in village irrigation rehabilitation and management. Farmers practised an effective management of village irrigation systems by indigenous strategies that prevailed for centuries.

It may be more economical to improve and enhance the quality of existing irrigation systems than to invest on new irrigation systems. Rates of new irrigation systems is relatively much higher than rehabilitation of old irrigation systems.

A lack of investment in O&M has been responsible in the poor performance of irrigation systems. Investment in O&M has not appreciably improved despite having increase in new construction and rehabilitation costs over part four decades.

Land sector

Recommendations in the land sector include national action to:

- finalize national land use policy;
- provide economic incentives for integrated land management;
- implement regulatory measures and create research, training and awareness to arrest land degradation;
- strengthen Department of Agriculture institutional capacity to implement the Soil Conservation Act and technical assistance services;
- create a suitable environment for private sector investment in soil conservation and other longer term management measures. This is well established in plantation agriculture and tobacco farming; and
- promote tree crops such as tea, rubber, coconut and export agricultural crops to reduce pressure on natural forests and increase cover against soil erosion.

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Investment in land development in Thailand

INTRODUCTION

Thailand is an agricultural country situated in Southeast Asia having a total area of approximately 51 million ha. About 70 percent of the north is mountainous, while most of the northeast consists of high plateau which has been deforested and has become mainly agriculture. Eastern Thailand is marine terrace of which 80 percent is agricultural. The southern peninsula has forests, rubber plantation and mining. Land is an important factor and is the foundation for agricultural production in Thailand.

The agricultural growth rate during the past decade has been achieved largely through expansion of cultivated land. Agricultural expansion was mainly achieved by clearing forest to create new farmlands, not through major increases in productivity. This has led to serious land pressures. Forests in Thailand have declined steadily and are now at a critical level, while agricultural land is over-exploited and increasingly degraded. Improper use of land resources has brought about problems of the loss of soil organic matter – soil erosion as well as land abandoned due to acidification and salinization. Such problems tend to be increasingly serious and affect the social and economic climate. Consequently, land development is an investment in maintaining and enhancing the future productivity of the soil. This paper provides an overview of Thai government land development programmes.

DIFFERENT PLAN PERIODS

From the early 1960s when the first National Economic and Social Development plan was initiated through the year 2001, when the Eighth plan ended, Thailand progressively conducted a variety of land management activities. Building institutional and public awareness of natural resource concerns as well as collecting and analyzing land resource information has helped the country identify and respond to land resource problems. Research activities conducted over many years have provided perspective to help address problems of soil quality and suggest how to increase agricultural yields. Technology transfer through varied training courses and demonstration projects has encouraged farmers to be aware of the importance of sustainable land development and use.

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However, land development has generally been weak and poorly funded. When compared to the problems affecting land resources in Thailand, service work can cover only small area. The total budget allocated to major land management activities from 1964 through 1992 was US$120 million, but investmnent stepped up in the following years. During the Seventh Plan (1992-1996) US$207 million was invested, and during the Eighth Plan (1997-2001), investment rose to US$305 million. Thailand also received external assistance to launch land development projects in the form of technical cooperation and grant aids.

In general, during the period Thailand's land development target activities included:

Collection of data for a land database Land use planning and soil suitability maps for cash crops were established. Moreover, the development of MIS, RIS and GIS database systems provide Thailand with three valuable soil databases – a soil database detailing soil series and related information, a land use database and a database of forest reserves.

Soil improvement and rehabilitation Compost and green manure are applied to improve soil over an area of 0.9 million ha. Problems such as saline soil and acid soil over an area of 0.86 million ha are successfully managed.

Soil and water conservation Soil and water conservation systems were established over an area of 0.8 million ha or 3.7 percent of the affected area. Vetiver grass is promoted as ground cover to be planted to prevent soil erosion in 0.19 million ha, and a land and water utilization system has been initiated in more than 76 000 ha.

Research activities During the period 1994 to 2002, government agencies conducted 1 892 land development research projects. The data and assessments realized through those projects have been distributed to the public through via computer network. Moreover, the agencies produced soil management reports classifying 62 soil series to be used as a manual for solving soil problems.

Information transfer Government agencies conducted training courses to transfer knowledge and useful information on land development to local staff and farmers. In addition, 1 007 land development villages were designated as information centres for transferring proper land development technology in their locality.

MANAGEMENT APPROACH

The following management approaches have been conducted:

Soil and water conservation measures

Soil and water conservation measures are extremely important for arable area in the country whose main occupation of the people is agriculture such as Thailand. This is due to losses of soil nutrients mainly by erosion process on the nuded area with no soil conservation measure applied. Consequently, no more soil nutrients left for plant growth as erosion process go on continuously for a long period of time. This will result in poor crop production at the long last. It is not possible to exploit the land for producing crop anymore.

The operation of soil conservation on farmland is being done by regional service centres throughout the country. The soil conservation practices have been implemented both structural and agronomic types. The most common of the former of soil conservation measure in the field terrace has been widely used in low slope area. Bench terrace is less common measure. Hillside ditches of the

Taiwanese type seem to be more potential. At present, various types of agronomic practices are implemented. These are compost application, green manuring, cover cropping, cropping systems, mulching, tillage practices, tree planting and agroforestry.

Soil conservation measures have been accepted and adapted relatively well in the alley cropping system. The problem of the technique is that it may affect crop yield. The only structural measure being widely adopted now is the small contour platform for growing rubber trees somewhat similar but smaller than the hillside ditches of the Taiwan style which is being used to a limited extent for growing cash crops in the north.

In the past three decades, it can be concluded that soil conservation measures are only suitable for Thailand's sloping land: high sustainable potential includes green manuring and cover cropping, alley cropping with contour hedgerows of leguminous bushes and agroforestry systems. Of medium sustainable potential is mulching, strip cropping and crop rotation, alley cropping with contour grass strips or trash strips and fertilizer application. Conservation tillage, contour cultivation, hillside ditches, terracing, and individual basins have low sustainability in Thailand.

Level of participation of people, farmers associations and NGOs

Most farmers, chief of village, district official and research official in local area.

Technical backup

Depletion of fertility in cropland is brought about by the combined action of many factors such as the removal of large amount of nutrient materials by annual cropping, losses of soluble constituents through leaching processes, and by the rapid rate of organic matter decomposition as a result of microbial activity in cultivated soils. In addition, the process of erosion is now recognized as one of the most serious forces in the rapid depletion of fertility and productivity of cultivated land.

Soil under natural condition with ample vegetation like forest and grassland erodes at negligible rate. But due to the demands of man for food, fibre, and other necessities that are acquired mainly through the use of land, some of the forestry and grassland are needed to be removed and replaced by the demanded crops, which mostly are intertilled or rowcrops. The intertilled crops afford little protection to the soil so that erosion has proceeded unchecked. Rowcrops production especially on highly eroded land year after year without proper soil conservation, therefore cause serious erosion then the land will become unproductive.

Ecological restoration

Soil conservation measures can help prevent environmental pollution by means of reduction of sedimentation. Since soil is slightly eroded due to proper soil conservation measure, many metals both heavy and light in the soil will not transport to some other places especially to many water resources such as river and brook.

Levels of project success and failure

Soil conservation projects have been implemented for nearly 40 years. At their inception in the early 1960s, soil and water conservation stations and units were set up throughout the country, especially in the north and northeast where erosion was not serious. Initially, terracing was introduced as a free service to farmers, linked with ploughing their fields without charge. Farmers were willing to accept the new methodology due to the free ploughing service. Later they removed the terraces because of the reduced cultivation area. Today, however, some farmers have come to realize the long term

benefits and accept some soil and water conservation measures and adopt them in their lands (especially in the north).

The obstacles to accomplish such activities may be due to (i) the lack of basic data and information needed for establishing appropriate soil conservation measures for the respective area, (ii) present work standards of extension workers do not allow for sufficient contact with farmers, (iii) approaches to farmers has been inappropriate as most projects are of a top-down nature, and (iv) the lack of adoption of soil and water conservation.

Organic matter and waste products

Some 36 million ha (70 percent) of total area can be classified as deteriorating areas with unfertile soils and limited plant nutrients. Similarly is approximately 31 million ha (60 percent) of lands are classified as areas facing a serious problem of low level of soil organic matter.

Soil degradation is caused by loss of soil organic matter including the failure of implementation to maintain satisfactory organic matter levels. Soil organic matter plays a major role in soil functions and quality such as a source of nutrients, promotion of favourable soil physical condition, soil biotic population and plant nutrients absorption. These beneficial effects to soil organic matter imply that the maintenance of satisfactory level of organic in soils is essential for sustainable soil management. Organic recycling for soil improvement project was set up to serve the resolution of farmers poverty in rural area of Thailand. The project was conducted in the rural development component of national development plans, beginning with the Fifth National Economic and Social Development Plan (1982-1986) until the present Its implementation consists of training, programme in compost making for farmers, field demonstration and extension of compost making and also green manure application and its seed production, and some research activities on organic fertilizers as well. It was launched in 38 provinces in the initial stage of the Fifth National Economic and Social Development Plan and later was extended to 76 provinces. To date, there is a project for sustainable agriculture established by the collaboration between Thailand and the DANCED project.

Most farmers, compost producers, development, environmental and energy-related NGOs participate in the organic recycling project.

Technical backup-up

Organic fertilizer is recommended to increase crop yields. Some experimental results conducted in eastern and northeastern Thailand showed that the application of organic fertilizer combined with chemical fertilizer would appropriately raise the crop yield (Figure 1).

Composting is the process of decomposition of waste products from farmlands and byproducts of agro-industry microbial activities. At present, LDD1 is an effective micro-organism for the decomposition process selected and isolated by government technical specialists. There are plenty of agricultural waste products such as rice straw, cornstalks and corncobs, soybean pods which can be used as raw materials for compost. Up to now, agro-industry has released various kinds of waste product such as bagasses, rice hull, sawdust and coconut dust which could be converted to organic fertilizer and are included a lot of animal waste in Thailand. Nevertheless, some legumes can be applied as manure by planting and incorporating in flowering stage to make the soil fertile, these plants are known as green manure such as Sesbania are recommended for lowland or paddy field mean while Crotalaria juncea and Vigna and Canavalia ensiformis are suitable for upland areas.

Ecological restoration

Compost can reduce environmental problems due to agricultural waste and industrial waste products by means of recycle processing from raw materials to organic fertilizer, reduces burning of rice straw

in paddy fields and decreases bad odour, insects and pathogens from organic garbage, diminishes environmental problems from various kinds of industrial waste such as bagasse, distillery waste, filter cakes from sugar factories and wastewater from canneries. Making compost from water hyacinth can solve water pollution due to concentrations of water hyacinth clogging canals, rivers and other waterways. Compost can maintain the balance of environmental ecology system.

Levels of project success and failure

The Organic Matter for Soil Improvement Project was set up in 1982 to encourage farmers living in unfertile areas, particularly in rural poverty area in 32 provinces to make 50 000 tonnes of compost. Implementation of the project target was achieved because farmers accepted the concept of organic fertilizer. However, the project in the Eighth National Economic and Social Development Plan had been present continuously from the Fifth Plan. Since 1982, 3 889 000 tonnes of compost was produced and 41 120 ha of green manure utilization was done by demonstration and extension. Recently, commercial companies have manufactured microbial accelerators for compost making and produced compost for commercial purposes.

SALINE SOILS MANAGEMENT

Two major measures, (i) prevention and (ii) improvement and reclamation were implemented in salt-affected areas.

Improvement measures are mostly applied in slightly and moderately saline areas. Adopted technology packages, e.g. salt-tolerant plant varieties, compost, organic matter, green manure, and soil amendment are used to improve soil properties and increase yields.

Prevention and reclamation measures are used in strongly saline soils areas. In the Northeast where strongly salt-affected soils occur, biological control as reforestation which include screening of suitable salt-tolerant varieties of plants with deeper rooting system and high consumptive use of water are recommended to prevent spread of soil salinization. These plants have been grown in recharge areas to reduce amount of excess water that percolated to the water table. This lowers the saline groundwater table to the depth that capillary rise will not bring saline water up to the soil surface. Reforestation minimized salt-affected area in the project site by a proportion of 5:1.

In the coastal areas where saline soils are formed from marine or brackish water sediment and subjected to inundation of sea water or brackish water during high tide, constructing of dykes or polders has been recommended to prevent the encroachment of sea water or brackish water and to leach salts from root zone with rainwater or water of lower salt concentration.

Reclamation processes usually required soluble calcium for replacing exchangeable sodium. Desalinization of these soils showed that at the depth of 0-100 cm the average EC was reduced by 40 percent, while the highest desalinization occurred at the depth of 20-40 cm.

Level of participation of people, farmers' associations and NGOs

In northeast Thailand's Nakonrachasima province, inappropriate land use resulted in soil salinization from the movement of saline ground water, and reduction of arable land and forest areas. A pilot project on reforestation for prevention of soil salinization was operated. Seventy percent of farmers from 31 villages agreed to participated and have their land reforested to prevent soil salinization.

Technical backup

Soil and crop management techniques, biological and engineering control measures have been conducted to assist in the prevention, improvement and reclamation of lands affected by salinity. Moreover, legislative measure, sometime is needed to protect deterioration of cultivated lands.

Monitoring land salinization was conducted by using satellite imagery in conjunction with ground verification. As salt-affected soils are dynamic, monitoring must be a continuing activity. This is useful in research, in preparing saline soil maps and, in particular, salinization control. Studies in the northeast and central plain regions helped classify salt-affected lands and in identifying improvements and control measures and research, e.g. programmes in reforestation, increasing crop yields in salt-affected lands and in influencing the effect of shrimp farming in fresh water areas.

Ecological restoration

Environment become important in terms of soil salinization problems. Although inappropriate landuse such as salt-making and brackish water shrimp farming give farmers high profit, they can cause serious impact on adjacent areas and the environment. This includes the reduced capacity of the land to provide long term economic value, the increased investment cost and the problem of soil and water management. In the northeast, inland saline soils are constantly expanding. Inappropriate land use results in soil salinization from the movement of saline water, and reduction of arable land and forest areas.

The improvement and rehabilitation of these areas led to the use of marginally suitable and unsuitable land which will result in ecological restoration including sustainable use of land.

Watershed management

The problems of catchment area of major rivers which are being largely degraded by forest encroachment and agricultural exploitation are now the serious situation of the country. The effects have caused severe erosion and sediment transportation downstream as well as many other changes in hydrological characteristics. The crisis has become more serious in this decade from consequent effects of flash flood alternate with water shortage. Then the need of watershed management becomes more imperative and should be taken into consideration.

PROGRAMME ACHIEVEMENT IN TERMS OF FOOD PRODUCTION AND SECURITY

Government has conducted many activities to help farmers solve soil problems and get more food production, including (i) the improvement of low to moderate saline soils by using African Sesbania and other kinds of green manure resulting in rice yield per rai increases of 225-300 kg/yr, (ii) improvement of acid soils in the central plain and acid and saline soils in the south by using agricultural lime with major crop yields increasing by 255 kg/yr and (iii) soil improvement by using compost and green manure helps increase major crops by 20 percent and decrease chemical applications by 20 percent.

Income and employment generation

Government agencies encourage income and employment generation by two main activities:

- Vetiver grass for soil and water conservation Farmers in the implementation area are employed to produce seedlings and plant vetiver grass and then sell them to the government. Green manure applications and the policies of purchasing and providing are conducted as follows:

- Purchase seeds of green manure plants such as black bean from the market. If there is not enough seed, government encourages farmers to produce plants and sell them to the government. Seeds will then be distributed to farmers. The local staff will train them how to grow, fertilize, harvest the plants and help them make a production plan. After harvesting, farmers are required to give back seed to the government in the same amount that they received.

Coordinate with local organizations who take care of farmer groups in encouraging farmers to produce seeds of green manure plants distributed by the government. Government then purchases all production by variety, quantity, quality and price.

Hire the private sector to produce the plant seeds. The government agency will identify such specifications variety, quantity and quality.

Historical trends

Economic policies

The Eighth Plan identifies one objective concerning the proper utilization of natural resources and environment to support sustainability in economic and social development and improvement of quality of life.

Regarding land resource, one department responsible for soil management has been assigned to reduce soil erosion of at least one million rai per year and rehabilitate at least one million rai a year of the area troubled by saline soils, acid soils and degraded soils

All development activities have to be implemented in order to maintain the increasing of agricultural product without harming nature.

The government village to be the representative of the government agency and let them provide suggestion concerning land development to farmers. The government agency also conducts the following activities to reduce soil erosion problem.

Land use zoning

Apply GIS to do land use zoning in 255 watershed areas. Establish soil suitability map at the scale of 1: 50,000 and the recommendation of appropriate soil management and follow up present land use to make a marketing plan. Establish land suitability map for brackish water shrimp farming at the scale of 1: 250 000 in 41 provinces and a map of proper area for brackish water shrimp farming in coastal area at the scale of 1: 50 000 in 25 provinces.

Soil and water conservation, soil improvement and soil and land management

Soil and water conservation

Prevent soil erosion by conducting soil and water conservation system and planting vetiver grass. Develop small-scale water sources: construct farm ponds; improve land by establishing proper system of land and water utilization.

Soil improvement and management

Improve soils by using compost and green manure; reduce soil problems such as saline soils and acid soils by using non- chemical methods; manage land utilization in the land that have special characteristics such as coastal land, highland and peat land.

Research and development

Government has conducted research studies based on groups of soil series and disseminates the research results on its own computer network.

GIS development

A government agency has developed its own computer network and linked data between its headquarters and local sites. As a result, farmers and the local staff will be able to use the data to solve their problems by one stop services.

Farmers and local staff potential development

The government agency has conducted training courses for the local staff as well as volunteer soil doctor and farmers to improve their efficiency in using high technologies to solve land use problems.

Administrative activities

The government agency has conducted the following three administrative activities: five techniques to increase work efficiency; public sector standard management systems and outcomes: PSO; Output-oriented budgetary system.

Investment trends and prioritization in land during the Ninth Plan (2002-2007)

The main objective of the Ninth Plan focuses on the development of human resource by improving education and health system, and management of natural resource and environment in accordance with the development of science and technology.

The plan also emphasizes on the balance between the utilization and the rehabilitation of natural resource which leads to sustainable natural resource utilization. It is expected that, in the year 2006, soil erosion problem area will be decreased at least 0.8 million ha. and the area of acid soil, saline soil as well as low fertility soil will be rehabilitated at least 1.6 million ha.

Long term perspective plan developed for land development

Aim Maintain the fertility of soil resource to be the base of sustainable agricultural development.

Objective To achieve sustainable land use by soil and water conservation and soil improvement practice.

Transfer land development technology to the public and promote popular participation to be responsible for soil resource management over the long term.

Strategies Land survey and classification by zoning land use area in accordance with client needs in each agency and follow up the situation of land utilization in order to evaluate and set the agricultural productivity and marketing plans.

Improvement of integrated soil resource management with focusing on area participation

Development of land resource management and research in order to get optimum use by accelerating the conduct of soil management and research according to group of soil series. GIS technology may be used for this activity.

Develop systems of technology transfer and public relation, land development service, soil data, and land utilization for the target group. Technology transfer will be done through the centre of agricultural technology transfer of each subdistrict: giving soil data, developing arable land for sustainable agriculture. Each activity will be conducted by using GIS technology.

Develop land information and GIS systems throughout the country as one-stop service centres; improvement of working system and development of capacity building by: supporting private sector and educational institutions to participate in government activities; and training government officials to use new technologies of administration, technique and operation concerning their job; reorganization by decentralizing some of officers to work in local area to support and strengthen the work of the local stations; developing work standard of the government agencies by using PSO, five techniques to increase work efficiency and output-oriented budgetary system.

CONCLUSION

Relate land and water development activities to the FAO Special Programme for Food Security. At present, sustainable agriculture is well known among researchers and should extend to the farmer. The principle of sustainable agriculture is to exploit natural resources such as organic fertilizer and biofertilizer as much as possible in producing crops and to try to reduce the amount of chemical substances in both fertilizer and pesticide. This can be achieved by introducing crop diversity and exploiting natural resources as much as possible.

The use of organic fertilizer from organic matter for soil improvement is well known among people who are aware of the toxicity of food due to the application of chemical substances. Such persons require organically produced fruits and vegetables so that now that there are specialized companies selling organic produce, and there are farmers willing to produce organic fruits and vegetables.

Total agricultural waste in Thailand is approximately 36 million tonnes/year. Industrial waste is 23 million tonnes/year and animal waste is 22 million tonnes/year.

Shrimp culture has been done in 22 455 ha in 23 provinces of arable land in Thailand's central plain. The rapid increase of inappropriate land use has resulted in decreasing arable land. Moreover, discharged saline water from shrimp ponds into adjacent areas by irrigation canals or seepage of saline water has caused soil salinization. This situation has impacted the availability of land for cultivation. In July 1998, the government acted with regard to such salinity problems, introducing a

total ban on shrimp farming in freshwater areas throughout the country and at the same time announcing its intention to reclaim the land to be use for agricultural purposes.

The adoption of sophisticated soil and water conservation technologies especially proper cropping systems plus adequate conservation measures and the application of the concept of sustainable agriculture will lead to the alleviation of farmer poverty.

Economic returns on investment of soil and water improvements

Agricultural land use often results in land degradation and the reduction of productivity. Degradation of land results in loss of current income and increase the risk and also threaten prospects for economic growth. Despite relatively low average return to agriculture, the cost of degradation, and thus the benefits of conservation, are substantial. However, there are methodological problems in estimating cost and benefit of soil and water conservation on regional or national level.

The economic impacts of erosion can be analyzed from two perspectives, on-site impacts and off-site impacts. Farmers are concerned only with the on-site costs and benefits of soil erosion, whereas society must also be concerned with off-site or external costs. Off-site costs and benefits are an integral part of the economic impacts on land degradation.

From the farmers perspective, costs of soil erosion consists of two components, direct cost; costs incur to farmers to undertake soil conservation measure and foregone output; the loss of current output results from using less soil. The benefits of soil conservation are the gains in current and future production and thus income incurring to farmers from having more soil available today and in the future. In measuring the on-site costs of soil erosion, the main objective is to estimate the present value of net income lost through excessive soil erosion, that is the difference between present value of net returns of farming system with soil conservation and present value of net returns with erosion.

Besides the on-site impacts, there are many possible off-site or downstream impacts of soil erosion for instance, reservoir sedimentation, effects on agricultural in lowlands, impacts on water supply and potability and impacts on drought or flood cycles. In measuring off-sites costs is to estimate the present value of any external costs arising from the downstream impacts, that is the foregone net economic benefits from any loss of downstream economic activity.

Adoption of soil conservation measure and maintenance and improvement if such practices are the ultimate measures of success of any soil conservation initiative. Farmers, especially subsistence ones, have limited financial resources to invest in soil conservation. Also factor, such as land tenure, credit and marketing systems discourage long-term investment and land productivity preservation. Farmers are reluctant to undertake efforts not providing income or reducing their input costs, either in cash or in-kind services. This means that conservation measures must have visible short-term benefits to farmers; benefits they would appreciate might be increased yield per land unit or better production per unit of labour. Technology that is appropriately designed and properly implemented is necessary for success.

Lessons from successful projects

The Organic Recycling for Soil Improvement project of the Land Development Department has succeeded in making Thai farmers aware of the benefits of using agricultural organic waste as compost for soil improvement. The department produces 150 000 packages of microbial activator LDD.1 every year for rapidly decomposing plant residues to make about 150 000 tonnes of compost per year. Microbial activator LDD.1 consists of such beneficial microorganisms as bacteria, actinomycetes and fungi having high efficiency in decomposing plant residues. Furthermore, the department promotes green manure production in agricultural areas and supports green manure seed programmes for farmers.

Management approach for land development projects

At present, government agencies have soil 'doctor' units throughout Thailand. Such units help farmers afford and apply the new technology in soil and water conservation and soil improvement in their fields so that farmers can make better use of their land area, increase their income by increasing crop production and preserve and improve sopil quality. In addition, soil and water conservation demonstration villages have also been set up as the pattern for farmers to adopt on their land.

An Organic Recycling Project for Soil Improvement has been introduced and promoted to Thai farmers by technical specialists from regional centres in 69 provinces. Thai farmers learn about soil management focusing on organic agriculture concerns such as building soil by adding compost, animal manure, green manure, and plant residues such as unburned rice straw and mulches.

Concering watershed development, management activitiy programmes have begun to improve land use such as:

- an Integrated Approaches Programme to generate a potential model of a participatory integrated management system at watershed scale. Popular participation techniques such as RRA and PRA encourage farmer participation and meet the needs of land users;

- a Critical Watershed Classification System has been launched to classify the degree of deterioration hazard set at four levels. Its evaluation methodology includes soil erosion, soil fertility, acidity levels, drought and flooding. The programme is designed to reveal criteria for rehabilitating the planning process;

- Land-use planning at watershed scale includes 25 major watersheds and 255 subwatersheds throughout Thailand.

Examples of development projects in land sector

The Organic Recycling Project for Soil Improvement is one example of development projects in the land sector. There is an extension policy regarding soil organic matter management using agricultural organic wastes to farmers in Thailand's land development villages. Officials in all regional centres support and promote the use of microbial activators (LDD.1) and green manure seeds as well as giving agricultural extension information on the role of organic matter in soil and organic waste utilization for producing organic fertilizers.

Thailand country report on investment in water

INTRODUCTION

Under its three most recent National Economic and Social Development Plans – the Fifth, Sixth and Seventh plans respectively – Thailand experienced a satisfactory expansion of its Gross Domestic Product (Table 1). Agriculture accounted for 69, 42 and 35 percent respectively in these plans, demonstrating that the agricultural sector is a very important but a not very efficient part of Thailand's national economic system.

Although Thailand is one of the world's top agricultural exporters and while the trend of production per hectare is rather high, its main economic crops such as rice and corn still have quite low production efficiency compared to other countries. In this regard, Thailand needs additional research and development (R&D), improvement of fundamental structures for increasing production efficiency (including irrigation), management, quality control in production and technology and expanded marketing.

BACKGROUND AND TRENDS

Since 1961, Thailand's water development for irrigation was implemented under the strategy and direction of comprehensive National Economic and Social Development plans. At the beginning, the emphasized target was construction of large- and medium-scale irrigation projects to increase new irrigable areas as much as possible to guarantee or reduce the risk of a lack of water in the agricultural sector. Development also included targets for hydropower development.

As a result of development in earlier phases, Thailand during the Fifth Plan was able to expand irrigable areas to 3.55 million ha or about 25 percent of its total agricultural land. Later strategy and policies in irrigation development changed as the result of competition in economic development as Thailand changed from being primarily agricultural to having an increasing emphasis on the industrial export sector as a newly-industrialized country.

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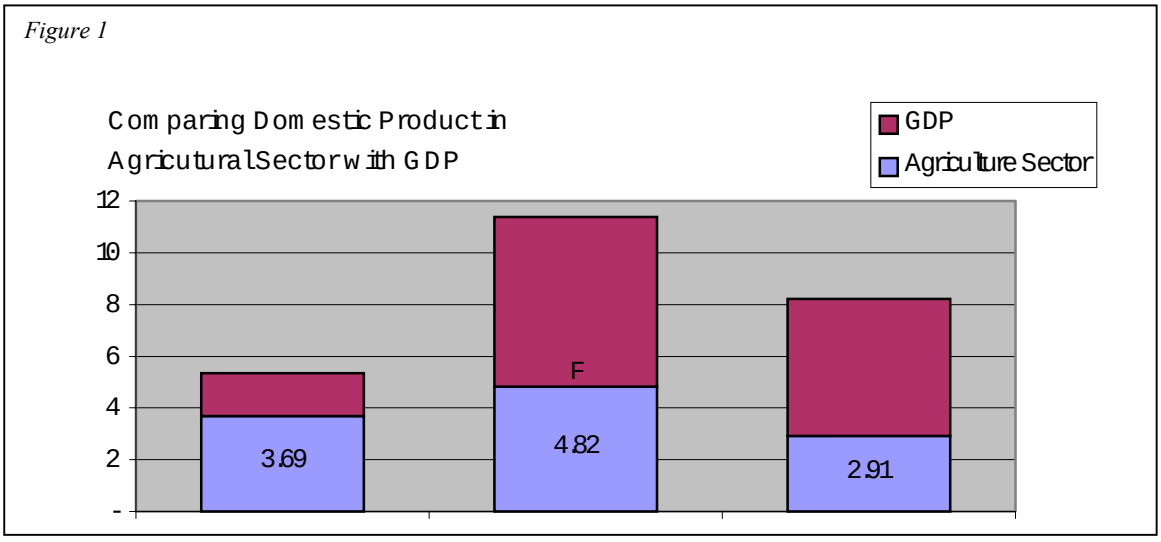
TABLE 1
Thailand's agricultural sector and Gross Domestic Product (NESDB)

National Economic and Social Development Plan	Gross Domestic Product (GDP)	Domestic product in Agricultural sector	Agriculture as % of GDP
Fifth Plan	5.34	3.69	69.10
Sixth Plan	11.37	4.82	42.39
Seventh Plan	8.21	2.91	35.44

This led to a lack of water from existing developed water resources due to the following reasons:

- increasing demand as farmers learned to make better use of their land, requiring more water from existing resources;
- growing water requirements in non-agricultural sectors, a result of national industrial development policy and investment, as well as population growth;
- low efficiency in irrigation usage because there were no irrigation fees;
- lacking an effective plan for basin development, duplication by many agencies in water resources development negatively affected potential basin development; and the
- limited topographic conditions for building large-scale irrigation projects together with substantial NGO opposition.

Figure 1



Economic crisis in Thailand in 1997 and the devaluation of the baht resulted in economic recession and a stretching of finances leading to budget shortages. In addition, the new constitution called for decentralization and the participation of local people for transparent implementation. The direction of water resources development for irrigation at present is reflected in the National Water Policy and Vision of the Royal Irrigation Department. It concentrates on increasing irrigation water use efficiency in existing irrigation projects instead of new water resources development and extension of irrigable areas. RID has attempted to emphasize farmer participation in on-farm water management. Construction of on-farm distribution systems by farmers themselves with government assistance is described in the Ditch and Dyke Act of 1962 (Buddhist Era 2505) and the Land

Consolidation Act of 1968 (B.E. 2511). The objective is to promote the most effective use of irrigation water as well as to prevent conflicts among farmers during any water use crisis.

THAILAND'S NATIONAL WATER POLICY AND VISION

By 2025, Thailand is projected to have sufficient water of good quality for all users through efficient management, organization and a legal system to ensure the equitable and sustainable use of its water resources with due consideration to the quality of life and participation of all stakeholders.

Thailand's national water policy

Thailand's nine-point National Water Policy and Vision as set forth by the Royal Irrigation Department details how this will be implemented:

- Accelerate promulgation of a Draft Water Act as the framework for national water management by reviewing the draft and implementing all necessary steps to make it effective, including reviewing existing laws and regulations;

- Create water management organizations both at national and river basin levels with supportive legislation. The national organization is responsible for formulating national policies, monitoring and coordinating activities to fulfil the policies. The river basin organizations are responsible for preparing water management plans through a participatory approach;

- Emphasize suitable and equitable water allocation for all water use sectors, and fulfil basic water requirements in agriculture and domestic uses, to be achieved by establishing efficient and sustainable individual river basin water use priorities under clear water allocation criteria, incorporating beneficiary cost sharing based on the ability to pay and the level of services used;

- Formulate clear directions for raw water provision and development compatible with basin potentials and demand, ensuring suitable quality while conserving natural resources and maintaining the environment;

- Provide and develop raw water sources for farmers extensively and equitably in response to water demand for sustainable agriculture and domestic uses, similar to deliveries of other basic governmental infrastructure services;

- Include water related topics at all levels of the educational curriculum to create awareness of the value of water, understanding the importance both of necessary and efficient water use and responsibility in maintaining natural and man made water sources;

- Promote and support participation, including clear identification of procedures, clear guidelines on the rights and responsibilities of the public, non-governmental and government organizations in efficient water management. Water management includes water use, water source conservation, monitoring and preservation of water quality;

- Accelerate preparation of plans for flood and drought protection, including early warnings, damage control and efficient and equitable rehabilitation with proper use of land and other natural resources; and
- Provide sufficient and sustainable financial support for action programmes in line with national policy, including water-related research, public relations, information collection and technology transfer to the public.

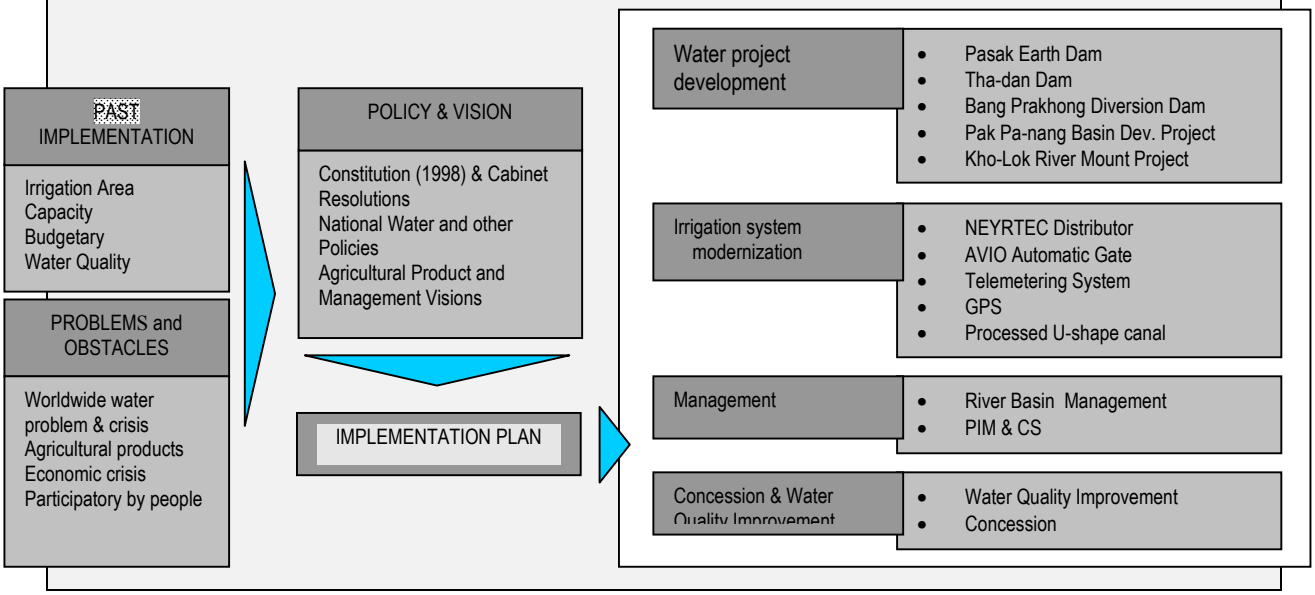
Water policy visions in the Ninth National Economic and Social Development Plan

Vision regarding natural resource management Thailand's 1997 Constitution is the fundamental base of national development and accelerates participatory rural development, decentralization, natural resource conservation and environmental protection, and good governance with public emphasis on accountability and highly efficient management. The vision (by steps) leads to good connections between subplans, good governance, high participation fat the rural, regional and national levels is expected and effectively developed in all areas.

Vision regarding agricultural production Thailand envisages agricultural production based on the sustainable use of natural resources, without prejudice regarding social status and to be advantageous to the environment.

Vision regarding local participation in irrigation management and cost sharing To change the traditional idea of farmers being one-way receivers from government (the government sector invests, manages, maintains and repairs irrigation system without payment) to be full participatants in terms of management and sharing the cost of operation and maintenance.

FIGURE 2
Flow chart – preliminary plan of Royal Irrigation Department



Because of continued development of efficient irrigation practices since implementation of the Fifth National Economic and Social Development Plan, large-, medium- and small-scale irrigation projects with a total capacity of 32 million m^3 covering some 3.52 million ha were built (Tables 2 to 7).

CONCEPT AND DIRECTION OF INVESMENT

Although Thailand's irrigation water requirement was projected to increase at the rate of 1.1 billion m^3 per year, average annual water resources capacity increased only 0.97 million m^3 (Khon Kaen University, 1986). Water shortage trends indicated above together with the slowing rate of expansion

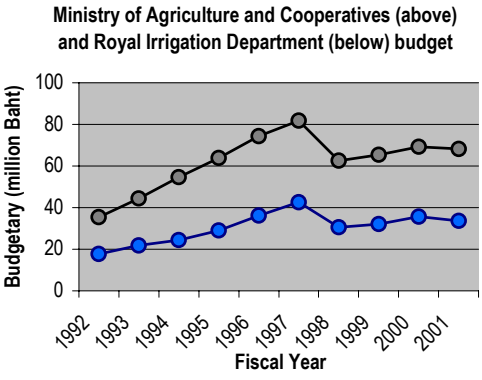
of new irrigated areas (Table 7) illustrate Thailand's difficulty in fulfilling its water demand. At the same time, environmental conservation is getting favourable attention in regard to water resource management.

TABLE 2
Budget of Royal Irrigation Department (RID), Ministry of Agriculture & Cooperatives (MOAC)

Year	National Budget (billion baht)	MOAC budget (billion baht)	RID budget (billion baht)	RID budget as % of MOAC budget
1992	460.4	35.450	17.753	52.53
1993	560.0	44.329	21.674	50.08
1994	625.0	54.694	24.435	48.89
1995	715.0	63.924	29.089	44.68
1996	843.2	74.351	36.180	45.51
1997	984.0	81.825	42.456	48.66
1998	800.0	62.581	30.567	51.89
1999	825.0	65.408	32.049	48.84
2000	860.0	69.227	35.638	49.00
2001	910.0	68.317	33.498	51.48

Source: Office of Budget Programming and Project Planning
Note: 1992-1997 US$=25 baht; from mid-1997 the baht fluctuated. In late 2001 it was about 44 Baht/US$1.

FIGURE 3



Therefore, it is necessary in Thailand's present and future water resources development to emphasize qualitative development through sustainable development approaches. This means to increase irrigation efficiency by using appropriate technology, to add value to irrigation water as well as to promote participatory irrigation management (PIM) by holding public hearings. The Royal Irrigation Department has supported the participatory approach and is ready to adapt its future plans with such participation. RID also introduced new approaches in irrigation management by:

- introducing appropriate technology in conjunction with local technology, adapting to partial or fully automated systems, for validity, reliability, speed, and equity support through an entire network or subnetworks;

- using equipment to replace skilled labour or local labour attracted from agriculture to industry; and

- decreasing water loss in canal systems by using concrete linings or by replacing pipe systems.

Additional approaches that Thailand has been implementing include:

- reducing water losses due to inefficient water resources management, expanding storage farm pond capacity (both as supplementary sources and as night storage);

- altering criteria or redesigning proper and easily operated irrigation works;

TABLE 3
Fiscal Year 2000 & 2001 Budget for Royal Irrigation Department classified by plan

PLAN	Yr. 1999	% of Total	Yr. 2000	% of Total
1. Management plan for agricultural water resource development	3.718	11.60	3.647	10.23
2. Large Scale Water Project Plan	6.881	21.47	8.793	24.67
3. Medium Scale Water Project Plan	3.987	12.44	5.302	14.88
4. Operation Maintenance and Development Plan	10.657	33.25	10.853	30.45
5. Land Used & Standard Service Plan	0.600	1.87	0.615	1.72
6. Research & Development plan for agricultural water resource	0.114	0.35	0.125	0.35
7. Rural Development Plan	5.950	18.56	6.124	17.18
8. Public Service Plan	0.104	0.32	0.108	0.30
9. National security Plan	0.040	0.12	0.070	0.20
Total	32.049	100.00	35.638	100.00

Source: Office of Budget Programming and Project Panning

- developing flood management and adjusting paddy cropping systems suitable for lowland areas;

- privatization and irrigation management transfer (IMT). Government plays a role as the technical advisor, supporting productivity improvement and directing implementation according to policy to maintain fair procedures;

- supporting entrepreneurship, ownership and partnership by encouraging farmers to undertake self-maintenance and cost sharing;

- replacing function structures by 'process structures' to create a system of participatory agencies.

SOME IMPLEMENTED PROJECTS

To accomplish the objectives of the policy and vision and to solve water shortage problems, Thailand has implemented various construction projects together with improvement of irrigation system and guideline in water management, classified as water resource development projects, irrigation system modernization, management and concession and water quality improvement

TABLE 4
Projects and programme loans allocated and pending approval 1995 to 2007

Source	Description	Budget	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
KfW	MIP-II Project	936.00													
JBIC	SSIRP (small-scale irrigation improvement & rehabilitation project)	2 010.30													
	Pasak Irrigation Project	1 529.36													
	Miyazawa Project	4 335.00													
	Grand Total (approval)	8 810.66													
ADB+JBIC	ASPL	5 700.00													
JBIC	Tha-sae Project	2 788.96													
	Upper Thachin Project	2 908.12													
	Flood Protection Project (Eastern Bangkok)	9 800.00													
	Mae-Wong Project	4 933.24													
WB	Dam Safety Project	2 004.00													
	IMM Project (Chao-Phraya Basin)	3 600.00													
	Grand Total (pending approval)	31 734.32													

Source: Office of Budget Programming and Project Panning
NOTE JBIC: Japan Bank for International Cooperative; ADB: Asian Development Bank; WB: World Bank

TABLE 5
Irrigation area and capacity by regions (Fiscal Year 1998)

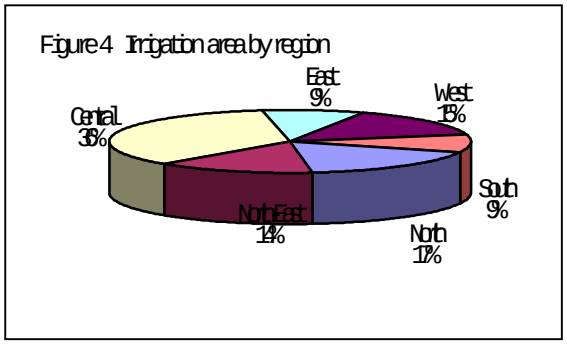
Region	Number of Irrigation Projects			Irrigation area (million rai)	Capacity (million m3)
	Large, Medium	Small	Total		
193	1 771	1 963	3.78	23.97	
276	4 023	4 299	3.10	5.37	
57	624	681	7.65	0.51	
74	530	604	1.96	0.66	
49	299	348	3.20	1.36	
82	987	1 069	1.99	0.27	
731	8 234	8 965	21.69	32.16	

Source: Office of Budget Programming and Project Planning.
Note: 1 hectare = 6.15 rai

Water project development

Expansion of irrigation area shown in Table 7 reflects the difficulty in building new water storage in support of rapidly rising water demand. However, Thailand continues to develop new water storage to support extended agricultural productivity. Existing irrigation projects are:

- The Pasak Cholasit Dam in Lopburi province (a zoned earth dam height 31.50 m, length 4 860 m) constructed from 1995 to 2002 (EIRR = 12.80 percent). Its main purpose is to store water for irrigating 21 600 ha and providing supplementary irrigation water for a lower Chao Phraya West Bank area of 320 000 ha. It also provides water for domestic use in metropolitan Bangkok and its vicinity, as well as providing flood protection for Lopburi and Saraburi provinces, promoting fisheries, transport waterways and water pollution control;



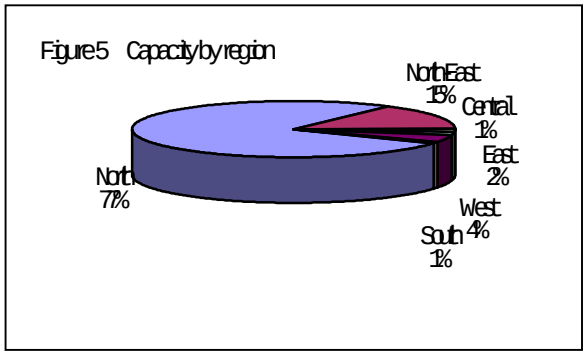


TABLE 6
Progress and trends in 10 years of water resource development

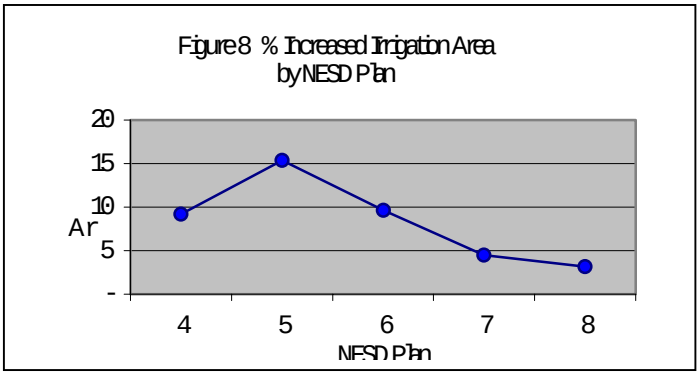
National Economic and Social Development Plan	Irrigation Area (million rai)	% Irrigation area over total Area	Capacity (million m3)	% increase in capacity over previous year
First Plan	9.720	3.031	14.472	n.a.
Second Plan	10.960	3.418	15.079	4.19
Third Plan	14.380	4.484	24.347	61.46
Fourth Plan	15.840	4.939	25.462	4.58
Fifth Plan	18.710	5.834	28.669	12.60
Sixth Plan	20.710	6.458	30.200	5.34
Seventh Plan	21.680	6.760	31.662	4.84
Eighth Plan	22.390	6.982	32.314	2.06
Ninth Plan	28.490*	8.884*	36.599*	13.26*
Tenth Plan	30.710*	9.576*	39.253*	7.25*

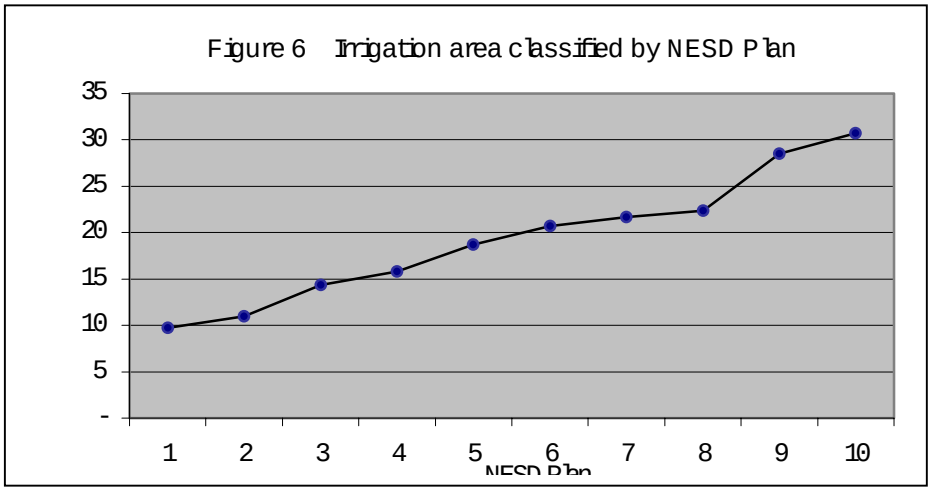
Source: Office of Budget Programming and Project Planning
Note: Asterisk (*) denotes projected figure.

TABLE 7
Increased irrigation area in percentage by NESD Plan

National Economic and Social Development Plan	Irrigation Area (million rai)	% Irrigation Area Increase by NESD Plan
1-3	14.380	
4	15.840	9.217
5	18.710	15.339
6	20.710	9.657
7	21.680	4.474
8	22.390	3.171

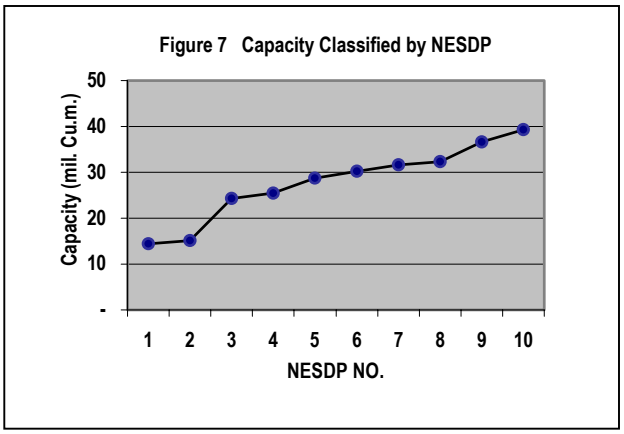
Source: Office of Budget Programming and Project Planning

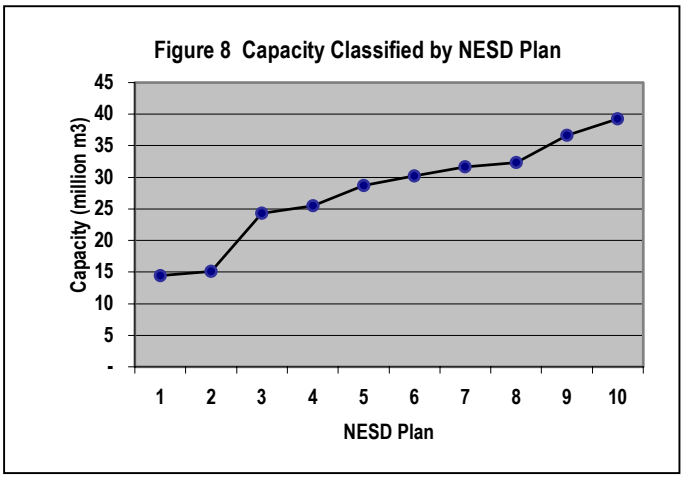




- The Khlong Tha Dan Dam in Nakhon Nayok province is a roller-compacted concrete structure with a height of 93.0 m, a length of 2 720 m and a capacity of 224 million m^3. Built from 1997 to 2004 (EIRR = 10.85 percent), its main purpose is to store water for irrigating an area of 29 600 ha, to provide flood control for the upper Nakhon Nayok basin, to reduce soil acidity and for domestic water supply of approximately 16.0 million m^3/year;
- Bang Pakong Diversion Dam, Chachoengsao province, is built of reinforced concrete, at a length of 166.0 m with a gate electronically controlled by computer. Built from 1996 to 2001 (EIRR value of JICA study is outdated), its main purpose is to provide water storage for irrigating 14 720 ha, providing protection from salinity intrusion, for fisheries, and domestic water supply of 18.90

million m^3/year, 69.70 million m^3/year for industrial use and to maintain waterway levels and clearance for local transport;





- Pak Phanang Diversion Dam, Nakhon Si Thammarat Province, built from 1995 to 2002 (EIRR = 13 percent) has as its main objective salinity control, storage of 70 million m^3 of fresh water, irrigating 83 360 ha, providing flood protection in the Pak Phanang basin, reducing soil acidity and managing freshwater and saltwater irrigation areas;

- The Kolok River Improvement Project in Narathiwat province, includes 30 breakwaters and groins of 750 m. Built from 1996 to 2002 (EIRR = 16.60 percent), its main purpose is protection of 22 km of shoreline, conservation of ocean resources in the economic zone, fisheries promotion, aquatic animal nurseries in the lower Kolok and Tak Bai rivers and flood protection in the lower Kolok Basin.

Irrigation system modernization

Thailand has introduced new technologies in new projects appropriate to the environment with greater efficiency in irrigation water control such as:

- Overnight storage and distribution systems: automatic control and water distribution to farms by replacing farm turnout (FTO) using NEYRTEC distributors;

- Hydraulically automated controllers or AVIO automatic gates: hydro mechanical devices for water level and discharge control which simultaneously controls water moving through irrigation structures and in all conditions of water sources;

- Telemetering systems: advanced information technology with World Bank support in cooperation from the Electricity Generating Authority of Thailand (EGAT), telemetering helps plan and manage irrigation systems in response to basin runoff, supporting a more efficient use of runoff and irrigation waters including flood risk warnings for adequate preparation. Telemetering systems were introduced in the Chao Phraya and Pasak River basins;

- Geographic positioning system (GPS): used in a reservoir sediment survey at Lat Krathing Reservoir, Chachoengsao province in conjunction with an echo sounding device, contour maps are produced and reservoir capacity is recalculated;

- Ready-made U-shaped canals: introduced in 1997-1998 in on-farm development, prefabricated canals reduce construction time and minimize excess right of way usage, increasing management efficiency. Pilot projects are located in Chiangmai, Ubon Ratchathani and Krabi provinces covering a total irrigated area of 2 080 ha.

Management

In Thailand the main objective is to coordinate development and water resources management as a system, linking specific natural resource concerns with broader environmental impact.

Participatory irrigation management and cost recovery, Thailand has set up two types of pilot projects, river basin management and participatory irrigation management (PI) and cost sharing (CS) projects.

- River basin management policies include:

  Water resources development policy Water resources development master plan for 25 basins together with the implementation plan of large and medium scale irrigation projects will be prepared. Suitable water resources will be carefully identified in order to control margin water for sustainable irrigation and flood protection through good feasibility studies and design;

  Water resources conservation policy Promoting conservation and rehabilitation of water resources to develop and improve operation and management structures of water resources for agriculture as well as domestic water. Measurement for operation, construction, conservation and maintenance of water resources ecology will be provided;

  Operation management policy Development and utilization planing for water resources as well as emphasis of basin management, project management and on-farm water management. Support water management activities and human resources development in water management. Research and design irrigation water utilization boundaries;

Improvement and maintenance policy Prepare master plan in improvement and maintenance, new develop/improvement project in accordance with the local administration and economical condition;

Conservation of agricultural land in irrigation area policy Emphasize productivity efficiency by using inefficient natural resources, identify the irrigation promotion zone;

Information technology policy Develop information concerning basin system and standardization of information. Using this information beneficially among policy and administrative levels. Follow-up and evaluate including updating information and connection by the up-to-date net work. Develop human resources; and

Public relations for irrigation policy Emphasize popular participation in water resource development and conservation, promotion and publication in development and the utilization and conservation of water resources. Demonstrate and inform those concerned with irrigation projects and conduct public hearings.

- Participatory irrigation management (PIM) and cost sharing (CS) comprises:

  Participatory irrigation management aims to strengthen farmer ability to participate in irrigation management, most importantly to build-up decision-making capacity in farmer organizations which corresponds with government policy in decentralization, privatization and community participation.

  Cost sharing (CS) allows farmers' sense of ownership by cost sharing in maintaining irrigation structures and facilities. Ready to use their rights to protect and maintain the project in sustainable ways. Costs beginning with construction extend through operation and maintenance (O&M). Farmers participate in intensive on-farm development and land consolidation cost. However, farmers participate in maintenance costs of small-scale irrigation projects.

  Irrigation management transfer (IMT) Privatization of O&M of irrigation projects may begin with outside contracting and at the same time, developing/strengthening farmer organizations by acknowledging and improving their capability, power of decision and readiness for project transfer through PIM. At the monitoring and evaluation (M&E) stage, performance indicators and service standards, PI&SS guides implementation, for example, of the ratio of land use to total irrigation area, irrigation efficiency, and farmer satisfaction with irrigation water sharing.

- Thailand has also developed and experimented with other types of management, including:

  Privatization of water resources development, transferring maintenance responsibility of irrigation projects to the private sector and water users groups by contracting. NEWMASIP, the left main canal of the Yang Chum Irrigation Project and 10 other large and medium scale irrigation projects were selected as pilot projects (ASPL).

  Integrated management of agro-industrial development and integrated rural development projects in irrigation area. Start with operation planning, preparation of whole season irrigation water, agricultural research and development (breeding and methodology), agricultural promotion and marketing with price guarantee at the pilot project of the country, Nam Oon Irrigation Project, Sakhon Nakhon Province.

  Development-oriented research on agrarian systems (DORAS) entitled *Chao Phraya Basin Water management: guidelines for development of efficient and fair water management*. Research on

growing paddy in flood-prone lowland areas and management of floodwater in the floodplain of the Chao Phraya Basin. Researchers applied the *Kamling* theory of flood management initiated by His Majesty the King of Thailand, dividing the flood area into drainage units or "boxes" with structures to control waterflow. Paddyfield floodwaters can then be adjusted.

Concession and water quality improvement

In addition to cost-free development from government, which has the main responsibility in agriculture, Thailand has considered other types of development such as partial concession using wastewater from the agricultural sector for domestic and industrial purposes. The projects are:

- Dork Krai-Mabtaput-Sattahip pipeline project: implemented by the Eastern Water Resources Development and Management Co., Ltd. Under the concession, 72 million m^3 of water from the Dok Krai reservoir is supplied for domestic and industrial use. In any water shortage, the Royal Irrigation Department may set irrigation water for agricultural purposes as the main priority.

- Water Quality Improvement: In addition to providing new water resources and increasing agricultural management efficiency for projects initiated by His Majesty the King, the Royal Irrigation Department (RID) concentrates on water quality improvement. RID conducts sponsored research and development under the Chai Pattana Foundation. Experiment has been conducted in the area of wastewater and found the tool can work satisfactory

CONCLUSION

Thailand is preparing the fundamental structure in order to increase efficiency in the agricultural sector, which is very important for our country considering the ratio of agricultural sector over the GDP.

Different conditions in the past together with the economic crisis of the country and the other factors in guidelines, measurement, policy and vision such as constitution 1997, national water policy, vision frame in natural resources management, agricultural productivity, and farmers' participation in the management and cost sharing. Therefore, Thailand must change its concept of water resources development from quantitative qualitative orientation. Implementations include increased irrigation efficiency, quantity of irrigation water, promotion in farmers' participation for water management.

Guidelines for Thailand's development can be classified in four main categories: 1) water resource development projects, 2) irrigation system modernization, 3) management improvement, and 4) concession and water quality improvement. Application of these concepts will solve Thailand's socio-economic problems as well as secure sustainable development in the agricultural and irrigation sectors.

Land and water investment in Viet Nam: past trends, returns and future requirements

BACKGROUND

Viet Nam's main land body extends along the Eastern coast of the Indochinese peninsula facing the sea in the east and south. It shares borders with China, Laos in the north and Cambodia in the west. Viet Nam lies entirely within the northern tropical zone. Average annual rainfall varies from 800 mm to 2 000 mm. Viet Nam's total land area is 33 million ha of which nearly 20 percent or more than 7 million ha is now cultivated. Some 4.24 million ha are planted in rice. With a population of 77 865 500 (2000) and an annual growth rate of 1.51 percent (1999), arable land is becoming a scarce resource. Viet Nam remains predominantly an agricultural economy. The agricultural sector employs more than 60 percent of the labour force and accounts for 30 percent of total GDP.

While it may seem that Viet Nam has abundant water resources, the amount of water generated is low compared to other countries (4 200 m^3 per capita). Water resources vary in different seasons and geographic areas. Some 70 to 75 percent of annual rainfall comes during three to four months in the rainy seasons, with up to 30 percent of annual rainfall coming in only one month, often causing serious floods. Rainfall in the three driest months normally accounts for 5 to 8 percent. Sometimes, however, it is as little as 1 to 2 percent which causes serious drought in many areas – as seen during the drought caused by El Nino in 1998-1999. Natural calamities such as storms, floods and droughts have traditionally threatened agricultural production and the living standards of people in many areas of Viet Nam. In addition, there are also problems in many areas with a high soil content of aluminium and salt.

The Government of Viet Nam considers the agricultural sector to be foundational to the successful implementation of industrialization and modernization of the country. Therefore it has given and continues to give high priority to agricultural development. Investment in agriculture has been increased in the past and is projected to expand in coming decades.

Investment in agriculture from the state budget during the period from 1996 to 2000 was 21 594 billion dong (15 000 dong = US$1) or US$1.44 billion or 21.75 percent of total investment in all social and economic programmes. The budget allocated for agriculture and rural infrastructure improvement was 1 432 billion dong (468 billion in external funding), while 13 008 billion dong (4 342 billion in external aid) or more than 60 percent of total investment for water resources development in the agricultural sector, 2 788 billion dong for forestry; 864 billion dong for rural water supply; and 3 503 billion dong for other activities. Investment details are presented in Table 2.

Dao Trong Tu, *Director, Department of International Cooperation*
Ministry of Agriculture and Rural Development, Viet Nam

TABLE 1
Agricultural portion of gross domestic product (billion VN dong)

	1990	1995	1997	1998	1999	2000
Total	76 707	228 892	313 623	361 016	399 942	444 139
Agriculture	30 314	52 713	65 883	76 170	83 335	88 409
Percent	39.5	23.03	21.01	21.10	20.84	19.91

(US$1 = VN Dong 15 000)

TABLE 2
Total investment for agriculture and rural areas during 1996-2000

Year	Total investment	Investment in agriculture and forestry	Percentage (2/3)
1	2	3	4
1996	79 367	5 140	6.48
1997	96 870	6 190	6.39
1998	97 336	6 325	6.5
1999	103 772	6 563	6.32
2000	120 600	7 629	6.32
1996-2000	**497 495**	**31 848**	**6.4**

INVESTMENT IN THE WATER SECTOR

Existing situation

During the last decade, the government and people of Viet Nam have made significant investments in construction of many irrigation systems. Annually, about 10 percent of the state budget and labour contributed by the people is used for irrigation development. The country now has 75 large and medium scale irrigation systems, many small irrigation systems, and nearly 600 large and medium reservoirs (with more than 1 million m^3 of stored water with an average dam height of more than 10 m). Viet Nam's existing water infrastructure is massive: over 3 000 small lakes and dams, about 2 000 pumping stations with a combined capacity of 200 MW in irrigation and 300 MW in drainage works, more than 1 000 drains below river and sea dykes, about 8 000 km of flood prevention dykes in the Mekong river delta and tens of thousands of kilometres of canals. Total fixed assets represented by state investment are valued 60 000 billion dong or US$4 billion (1998).

Using this infrastructure, 3 million ha of croplands are irrigated, 1.4 million ha of winter-spring crops in northern provinces are drained, 700 000 ha of land are protected against saltwater intrusion, and 1.6 million ha of acid sulphate soils in the Mekong delta are being improved. This infrastructure hasgreatly reduced the severity of floods and droughts, expanded cultivable area, improved soil, and increased food production to its present level of almost 32 million tonnes (1998).

TABLE 3
Investment from state budget for agriculture and rural in period 1996-2000 (billion dong)

	Total investment	Investment for Agriculture	Percentage
Total investment			
1996	16 544	3, 373	14.34
1997	20 570	3 889	18.91
1998	22 209	3 765	16.95
1999	26 197	5 855	22.35
2000	28 000	5 712	20.40
1996-2000	**113 521**	**21 594**	**19.02**
Central Government			
1996	8 969	1 196	13.34
1997	9 861	1 943	19.70
1998	10 076	658	16.46
1999	16 000	2 952	18.45
2000	13 000	2 705	20.81
1996-2000	**57 906**	**10 455**	**18.05**
Local government			
1996	7 575	1 177	15,54
1997	10 709	1 946	18.18
1998	12 132	2 107	17.37
1999	10 000	2 903	29.04
2000	11 000	3 054	27.76
1996-2000	**51 417**	**11 188**	**21.76**

Note: 15 000 Dong = US$1

The dyke system consists of 5 700 km of river dykes, 2 000 km of sea dykes and a network of dams, drainage canals and embankments designed to prevent flooding in the Mekong river delta, contributing both to increased production and socio-economic development. The dyke systems in the Red, Ca and Ma river systems are most important. Their success was demonstrated by the Red River dyke system preventing flooding in 1991, when water levels reached 13.6 m in Hanoi and 7 m in Pha Lai. Similarly, the sea dyke system in northern and north-central Viet Nam now prevents saltwater intrusion and can withstand storms of 8 to 9 on the Beaufort scale (unless there is a concurrent high tide) while systematic embankments in the Mekong river delta protects summer-autumn paddy and prevents early flooding in August.

Large- and small-scale irrigation systems annually provide more than 4 billion m^3 of water for industrial and domestic needs. Large-scale integrated irrigation and hydropower infrastructure such as the Hoa Binh, Tri An and Thac Ba dams prevent floods, provide water for downstream areas and yield large amounts of hydropower (some 10 billion kWh/yr) to the national electricity grid. They also contribute to further development in transportation, fisheries and tourism.

TABLE 4
External funds (ODA) for agriculture sector 1996-2000 (billion dong)

Subsector	1996-2000			
	Total	Ministry-led	Local authority-led	ODA/Total Investment
Agriculture and rural development	468	445	24	32.71
Water resources	3 432	2 822	610	26.38
Forestry	552	409	142	19.79
Rural infrastructure	330	181	149	38.22
Total	4 783	3 858	925	22.07

The irrigation schemes contribute to the elimination of hunger and poverty alleviation in rural areas, especially in mountainous provinces. In many localities, irrigation schemes have facilitated the creation of new economic zones, created better conditions for fixed cultivation and resettlement, and have contributed to the reduction of shifting cultivation. In many places, irrigation schemes combined with small hydropower installations provide light to remote hamlets. In the Mekong River delta, the saying is that where there is fresh water, there are people.

Many irrigation systems have contributed to improvement of the environment and tourism, for example, by creating beautiful landscapes such as Suoi Hai, the Dong Mo-Ngai Son lakes, the Dau Tieng, Nui Co and Dai Lai lakes. Irrigation systems now provide flood protection; areas which in the past were often subject to flooding now escape that problem, making peoples' lives safer, facilitating overland transport and reducing the incidence of disease.

Shortcomings and challenges

However, the system of irrigation schemes in Viet Nam still suffers from many shortcomings and challenges. For example, the initial construction cost for irrigation construction in Viet Nam has been low, at some US$1 000-US$2 000/ha while in countries with similar conditions it reaches from US$3 000-US$5 000 or US$10 000/ha. However, inexpensive construction has come at a loss of quality or only partial completion. Irrigation usage fees are insufficient to cover costs of management and operation (O&M), maintenance and repair of the irrigation network, leading to a process of degradation. Improper management leads to water wastage. Some irrigation works can carry only 60 percent of designed capacity – very serious in dry years when much of the crop can be lost due to the shortage of water.

Management of existing irrigation systems at the on-farm level has not been reformed during the ongoing economic transition process. Further, management of irrigation construction at local level has not yet been adapted to the market mechanism

Irrigation systems initially designed to provide water for paddy now needs to be improved to meet the present demand for multi-cropping and crop diversity. Construction of irrigation systems for fruit trees and industrial crops in mountainous areas, concrete-lined canals, and application of advanced watering techniques to reduce water consumption are now urgent requirements.

At present, one million people in the upland areas have insufficient water for domestic consumption and only 30 percent of the rural population has access to clean water.

Dyke systems and other flood prevention works should be improved and expanded to withstand even exceptional climatic conditions. There is a need now to take all necessary measures to prevent floods during the coming years. This is a serious challenge for the water management sector. Planning for water resources usage has so far been done on a sectoral basis only, without considering forests, production, the daily needs of local people and the environment. In consequence, many surface water bodies have been exhausted. Most attention has been given to supplying water, while there has been less attention to the drainage system. In addition, emphasis has been given to water for agricultural production with less attention to domestic water use and other socio-economic needs. Finally, within agricultural production, paddy production was given priority while the needs of dryland crops, subsidiary crops, cash crops and fruit trees were neglected. Although water is abundant during the rainy seasons, too little is collected and saved for the dry season. Existing reservoirs can store only 6 percent of total annually generated water resources: for water coming into Viet Nam in rivers from abroad, the storage capacity is only 2.8 percent.

Water sources are becoming polluted due to industrialization, urbanization and high growth rate of population. Over-exploitation of groundwater resource has caused supply difficulties in many areas.

Water resource management is still scattered and there is overlap between ministries, sectors and localities. Management by river basin has not been implemented; neither is there the systematic establishment of irrigation systems by river basin.

IRRIGATION SYSTEMS DEVELOPMENT/WATER MANAGEMENT OBJECTIVES

Water resources in Viet Nam are relatively abundant in the rainy season and can be exploited for different purposes: domestic use, food production, industry, energy development, transportation, tourism and environment, and socio-economic development. In the major river valleys, the water level can be maintained over the entire year, except in Binh Thuan province, where there is a need to transfer water from Dong Nai. There are also technical difficulties in arranging irrigation in the Mekong River delta. Building water retention structures in upstream countries may create additional water shortages during the dry season downstream.

- Industrialization and modernization are accompanied by urbanization, leading to increased water demand for domestic and industrial use, which leads to increased demand for construction of more water storage and distribution works – which in turn leads to the need for drainage and wastewater treatment facilities.

- The more highly developed the economy, the more sophisticated systems for protecting society from natural calamities must be. Both the dyke system and flood regulation structures at residential and important economic production areas should be strengthened to ensure safety, limit losses, and enable sustainable development.

- The average agriculture land area per capita is very low. At present, there are about 7 million ha of agriculture land, giving an area per capita of less than 0.1 ha. Even if the area of agriculture land could be increased to 10 or 11 million ha over the next few decades, the expected population growth (to 140 million by 2040) would make the average remain below 0.1 ha per capita. Therefore, increased agricultural production cannot only be achieved through expansion in the land area cultivated but must be accomplished mainly through the intensification of cultivation. Increasing areas of agricultural land should be made able to carry two or three crops per year. Further, protective measures should be taken that ensure continued productivity of the land despite natural calamities in both dry and rainy seasons.

The irrigation network is extensive and there has been no major breach of the dykes in the last 20 years. The high food production level reached in 1998 demonstrates the robustness of the agricultural production system. However, much of the irrigation and dyke system consists of low-cost construction which might not be able to fill their function in extreme situations or flood or drought.

Structural quality will also deteriorate without regular maintenance and upgrading, The irrigation system should also be gradually modernized to support the transition in the cropping structure, irrigating more vegetables, subsidiary crops, cash crops and fruit trees. Water and soil should also be used sparingly to protect the environment.

At present, Viet Nam faces many difficulties, such as the changes in global climate and ecological changes due to local deforestation; increased frequency of natural calamities; increased production of waste which pollutes water sources due to industrial development and growth of urban areas. In this situation, it is necessary to develop irrigation within the framework of comprehensive water resource management and exploitation to obtain multiple benefits for industry, agriculture, and livelihood of the people. Integrated management and utilization of water resource should be implemented according to the Law on Water Resources. New organizations for water resource management should be established, such as a *National Water Resource Council* and management boards for planning of river basins. The quantity and quality of water resources should be monitored to facilitate water management according to the new law.

By the year 2010, the irrigation schemes must be able to meet the demands originating in Viet Nam's industrialization and modernization:

- *For agricultural production*, 11 million ha of land should be fully utilized, of which annual crop production areas would be 9.7 million ha for production of 36 to 38 million tonnes. Clean water must be ensured for domestic use and for supply to industrial zones. Water demand in 2000 is estimated at 72 billion m^3, of which 61 billion is for agriculture and 11 billion is for domestic use and industry. Water demand is expected to increase to 90 billion m^3 by 2010, with agriculture needing 74 billion m^3 and industry and household use at 16 billion m3. Demand is expected to increase particularly rapidly in the Mekong river delta, the southeast, the mountains and in the central highlands. Drainage should be ensured in flood-prone areas.

- *For flood prevention and limitation of damage by natural calamities*, the dyke system must be improved. The Red River dyke system should be strengthened and improved in quality to control water flow even if water levels reach historically high levels. More reservoirs should be created to reduce fluctuations in water flow. The sea dyke system must be strengthened to withstand storms of 11 and 12 on the Beaufort scale. In the Mekong river delta, an area safe from severe flooding in areas of shallow water levels should be created, where people from areas of deeper inundation can find safety. In large river valleys, integrated construction in which flood prevention is combined with irrigation and electricity generation must be created.

The planned Son La hydropower plant at Ta Bu and the Dai Thi plant on the Lo river are highest priority, followed by Cua Dat on the Chu, Ban Mai on the Ca, and Ngan Truoi on the La rivers, respectively, along with plants on the Huong, Bo (Thua Thien Hue) and the Dinh Binh plant on the Con river. The plant on the Phuoc Hoa river must be constructed as early as possible to overcome serious water shortage in the Ho Chi Minh City-Dong Nai-Vung Tau triangle. The 'stair' on the Dong Nai river will be formed after the Han Than-Da Mi plant is finished. The Dai Ninh plant should be started to generate electricity and provide water for the Luy river region (Binh Thuan). These are strategic plants; apart from building such large plants throughout the country, small- and medium-scale plants in the mountains and central highlands have important roles to play in socio-economic development, hunger elimination and poverty alleviation, and as a basis for establishing agricultural and industrial production zones.

Dykes preventing saltwater intrusion and regulating water flow in the Mekong river delta, particularly increasing water retention capacity in the dry season, should be completed. Groundwater resources should be protected and exploited safely for domestic use in the Mekong watershed, the central highlands, the central coast and in the southeast. The problem of insufficient water for domestic use by one million people in upland areas should be solved. Water resources must also be provided as needed for development of industrial zones.

- Irrigation systems and related infrastructure such as pumping stations, mechanical facilities and electricity transmission lines should gradually bemodernized. Channel systems should be consolidated. Existing irrigation works should be utilized to their full design capacity. Small irrigation systems in mountainous area must be strengthened. The area watered and drained for cash crops and fruit trees should be expanded and soil and water conservation must be practised on sloping land.

- Viet Nam's capacity for scientific research, water resource management, planning, design, construction and application of new materials for irrigation construction should be increased integrating new technologies.

- Appropriate policies and procedures should be formulated to support the introduction and use of the coming Law on Water Resources.

- These tasks show that irrigation is very important for Viet Nam's socio-economic development, for the sustainability of production and for protection of the environment. There is need for US$5-7 billion of state funds in this field.

PRIORITIES FOR INTERNATIONAL ASSISTANCE SUPPORT

Irrigation schemes

Because of the central importance of irrigation to Viet Nam's national economy and social needs the following priorities have been established for international assistance:

Construction of multipurpose irrigation systems. Regulating water levels to create water resources for both national economic sectors and environmental improvement. Build works which regulate floods and reduce losses caused by natural calamities, works to prevent saltwater intrusion; plants to treat wastewater and protect water quality; works to drain low-lying areas to improve living standards.

Improve existing irrigation systems to take full advantage of their capacity for multiple cropping and crop diversification. Modernize works and apply advanced water technology combined with traditional techniques to save water and maintain humidity for longer time. Strengthen the canal system.

Invest in irrigation control systems: communications for flood prevention; strengthen reservoir management; establish wastewater quality standards and programmes for clean water and rural environmental hygiene; strengthen management capacity in water resources and irrigation; formulate national water resources strategies; and prepare integrated plans for river basin and irrigation development.

By-law preparation: preparing by-laws including decrees for implementing the Law on Water Resources, on administrative punishments in the water resource sector and on water pricing. Revisions of laws on the exploitation and protection of irrigation constructions, on dykes, and on flood and storm prevention, so that they become compatible with the Law on Water Resources. Prepare inter-ministerial circulars and regulations on water resource management and on prevention of losses caused by water.

Establish water resource management agencies in accordance with the new Law, such as a Water Resource Management Council and management and planning agencies for river basins and investigation of water resources.

Investigate the extent of water resources (including surface water and groundwater), establish data banks and related resources.

Training human resources for development of irrigation and water resource management.

Licensing exploitation and utilization of water as well as for wastewater emission.

INVESTMENT IN THE LAND SECTOR

From 1996 to 2000, the state budget of Viet Nam allocated 1 432 billion dong for agriculture, of which 468 billion is external funding. Investment in land development is 6.61 percent of total funding for all sectors of agriculture. Investment for agriculture, however, is mainly for rural infrastructure with only a small amount for land (improvement of agriculture production on land). Investment in land concentrates to sustainability of food production to ensure national food security; improvement of management of natural resources (including ecological systems and environmental protection); and poverty reduction, or increasing living standards for rural areas and improvement of rural infrastructure

ASSESSMENT OF INVESTMENT IN AGRICULTURE

Thanks to the high level of attention by the government in the past, agricultural production has achieved encouraging results:

TABLE 5
Land-related investment (1999) (billion dong)

	Total	Construction & assembly works	Machinery & equipment	Others
Total	**5753.0**	**4286.3**	**381.1**	**1085.6**
I. Agriculture	4124.2	3911.2	293.6	919.4
1. Cultivation	776.2	509.2	134.1	132.9
+ land reclamation	98.2	84.7	0.3	13.2
+ Services for cultivation	275.8	172.5	55.4	47.9
2. Livestock	230.6	156.0	5.5	69.1
3.Water resources	4117.4	3246.0	154.0	717.4
II. Forestry	628.8	375.1	87.5	166.2

The growing rate of agricultural sector has been increased continuously with average rate 4.3 percent in the period 1989-1999. From a rice-importing country, Viet Nam has become the second largest rice exporting country worldwide. Agriculture has change from self-sufficiency to a diversified, commercialized and export-oriented agriculture.

Food production from 1989 to 1999 doubled; every year food production rose by 1.3 million tonnes, coffee-growing areas expanded 20 times, the production of rubber, tea and cashew nuts increased by five times, four times and four times respectively. Rice, coffee, tea, rubber have become main products for export. Income from export increased 13 percent annually and occupied 30 percent of production exported by all national economic sectors.

Box 1
Agricultural land in Viet Nam

Total land: 33 million ha
Agricultural area: 11 million ha
(33% of total)
Cultivated area: 7 million ha
(21% of total)
Rice fields: 4.25 million ha
(12.9% of total)
Rice field area (irrigated): 3.4 million ha
(80% rice fields)

Technology succeeded progress. Advanced and modern technologies/methods in agricultural sector have been developed or applied which contribute to the improvement of yield and quality of plants and animals.

Agricultural structures have changed positively, moving toward an efficient and diversified agricultural sector. Many concentrated production areas have been created. Rural infrastructure has been significantly improved. The income of most farmers is rising and living conditions of people in rural, mountainous areas have improved. Rehabilitation of forests and reforestation has progressed: after 10 years Viet Nam has 1 464 million ha of forest; deforestation declined from 100 000 ha/year in 1980 to only a few thousand ha/yr today. Forest cover rate in 1999 reached 33 percent (11 million ha).

CHALLENGES IN LAND DEVELOPMENT

Viet Nam has 10 million ha of barren land (hills, mountains) of which some area can be cultivated. the income from 8.1 million ha cultivated land is low with US$1 000 ha/yr. Rural labour potential and local people's capital resources are now still not yet mobilized effectively for production

Box 2
Water in Viet Nam

Natural area:	330 000 km^2
Population:	76.8 million
Average rainfall:	1 750 mm
Rainy season:	70-80%
Dry season:	20-30%
Number of rivers:	1 360 (L>10 km)
Annual river flow:	830 billion m3
	(63% or 522 billion m3 generated outside VN)
Storage volume:	65 billion m3
Storage/natural flow:	7.8%

Viet Nam's agriculture is still underdeveloped, with low productivity and efficiency, and low competitive capability. As of 1994 more than 70 percent of farmers household owned farmlands of less than 0.5 ha. Investment in land is low. Agricultural services, including marketing for agricultural production, is weak. Due to various constraints, government investment in agriculture is not at sufficient levels.

CONCLUSIONS

Improvement of efficiency of planning activities: investment efficiency in the rural infrastructure (including irrigation, rural roads and household living areas) and concentration of investment for targeted national and sector programmes such as: resettlement and new economic zones, drinking water, sanitation and rural environment, seeds and animal, and 5 million ha of forest addition; improvement of land use planning to mobilize all potential of areas to increase income of farming; changing investment structures: government should increase investment in agriculture and rural development (including water resources and land). Enhancement of managing institution and

strengthening state administrative mechanism in order to mobilize and efficiently utilized external assistance for development of

Viet Nam's strategy for irrigation development and water resources management to 2010

Challenges

- Low initial investment (US$1 000-2 000/ha)
- Degraded constructions: some only reach 60 percent of designed capacity
- Lack of water, dam safety for hydraulic works
- Management of local level irrigation construction not consistent with market mechanisms
- One million people in uplands lack clean water supply: only 30 percent of rural people have clean water
- Planning for protection and utilization of water resources is not comprehensive
- Exhausted water resources in many places
- Scattered and overlapping management of water resources between Ministries, sectors and local level; management by river basin not yet implemented

Targets for the year 2010

- ensure clean water supply of 72 billion m^3: agriculture: 61 billion m^3; industrial and domestic use: 11 billion m^3 and 90 billion m^3 by year 2010 (agriculture: 74 billion m^3; industry and domestic use: 16 billion m^3);
- ensure drainage for flooded areas;
- improve environment and ecology;
- implement a Red River dyke system to ensure the stable flow of water and prevent flooding at highest water levels;
- install a sea dyke system to withstand storms of 11 to 12 on the Beaufort scale and prevent coastal saltwater intrusion;
- ensure flood security for the Mekong river delta;
- establish integrated water infrastructure in large river basins
- overcome water shortages in Ho Chi Minh City-Sang Nai-Vòng Tau triangle;
- develop small- and medium-scale water infrastructure in mountains and Central Highlands;
- complete construction to prevent saltwater intrusion and regulate water level in Mekong delta;
- provide basic water supply to 1 million people in upland areas;
- strengthen scientific research, water resource management, capacities for planning, design of irrigation construction and applications of new construction materials; and
- complete the legal documentation system under the Law on Water Resources

Priorities for investment in irrigation development

- multi-purpose irrigation schemes;
- flood regulation and reduction of losses by natural calamities;
- infrastructure to prevent saltwater intrusion;
- construction for wastewater treatment;
- construction for drainage channels for flooded areas
- improve existing irrigation works;
- consolidate dykes and canals system improve irrigation control system;
- improve weather forecasting system and natural calamity prevention/reaction information;
- strengthen reservoir management capacity;

- establish management networks for wastewater treatment; and
- provide clean water and hygiene in rural areas.

Box 3
Large dams in Viet Nam

Number of large dam (1959-1999):	500
Of which H>25 m:	*50*
H>40 m:	8
Highest dam (Hoa Binh):	128 m
Storage capacity:	30 billion m3
Irrigation:	477 000 ha
Power generation:	3 595 MW
Sea and river dyke H>10m:	400 Km

ANNEXES

ANNEX I

Regional Consultation on Investment in Land and Water
3-5 October 2001, Bangkok, Thailand

AGENDA

Wednesday, 3 October 2001

08:00-08:40	Registration
08:40-08:45	Welcome address by Dr. K. Siegert, Secretary of the consultation
08:45-09:00	Introduction of participants
09:00-09:30	Opening address by Dr. R.B. Singh, ADG/RR
09:30-10:00	*Benefits of investment in land and water* (Mr. K. Yoshinaga, Director AGL)
10:30-11:30	*Investment in land and water, past successes and failures, future direction* (Prof. Y.K. Alagh, resource person)
11:30-12:00	*Investing in irrigation and drainage in the context of water policy and institutional reform* (Mr. T. Facon, FAO/RAPG)

COUNTRY PRESENTATIONS

13:00-13:30	Bangladesh
13:30-14:00	Cambodia
14:00-14:30	China
14:30-15:00	DPR Korea
15:30-16:00	India
16:00-16:30	Indonesia
16:30-17:00	Lao PDR

19:00 Welcome dinner hosted by Dr. R.B. Singh, *Assistant Director-General and Regional Representative,FAO/RAPG,* at Royal Princess Hotel

Thursday, 4 October 2001

08:00-08:30	Pakistan
08:30-09:00	Republic of Korea
09:00-09:30	Sri Lanka
09:30-10:00	Thailand
10:30-11:00	Viet Nam
11:00-12:00	Group discussion
13:00-17:00	Group discussion

Friday, 5 October 2001

08:30-10:00	Group discussion
10:30-12:00	Drafting of conclusions and recommendations
13:30-15:00	Presentation of conclusions and recommendations
	Discussion and adoption of the ***Bangkok Declaration***
	Close of consultation

Annex II

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