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CURRICULUM DEVELOPMENT

FOR

PLANT PEST MANAGEMENT IN ASIA-PACIFIC

REGIONAL OFFICE FOR ASIA AND THE PACIFIC (RAP)
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
BANGKOK, THAILAND

CURRICULUM DEVELOPMENT FOR PLANT PEST MANAGEMENT IN ASIA-PACIFIC

Proceedings
of the
Expert Consultation on Plant Pest Management Curriculum Development for University and Related Institute Education in Asia-Pacific held from 25–28 April, 2000 at the Regional Office for Asia and the Pacific (RAP), Food and Agriculture Organization of the United Nations, Bangkok, Thailand.

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PREFACE

This Expert Consultation on Plant Pest Management Curriculum Development for University and Related Institute Education in Asia-Pacific was held from 25–28 April, 2000 at the Regional Office for Asia and the Pacific (RAP), Food and Agriculture Organization of the United Nations, Bangkok, Thailand. It was the first of its kind to bring together key experts in the field of plant pest management to initiate the process towards harmonizing the plant pest management curriculum for the region.

National experts from China, India, Indonesia, Malaysia, Pakistan, Philippines and Thailand participated and presented their country review papers. The overview situation for the region was presented by the resource expert from CAB *International* (SEARC). Two specific topics covering mainly the plant pest management curriculum for farm level implementers were also delivered; one from the FAO Programme for Community IPM in Asia and the other from the Thai Education Foundation.

The papers presented in the Expert Consultation contained invaluable information and experiences pertaining to the development of plant pest management in the region. They include important aspects, such as, the origin and historical development of the curriculum, current status and the future plans. Weaknesses and constraints in the curriculum development were highlighted and suggestions for overcoming them made. The Expert Consultation addressed many issues arising from the ensuring discussions and made a number of specific and general recommendations for follow up, including proposing the establishment of the “Asia-Pacific Working Group on Plant Pest Management Curriculum Development”.

This compilation brings together the diverse aspects of plant pest management curriculum development in the Asia-Pacific region. It is hoped that the experience and information collated, including the recommendations derived from the critical appraisals in the Expert Consultation, will be useful in providing the current baseline on curriculum development for plant pest management in the region. Hopefully, from this foundation, relevant future programmes and workplan could be formulated to progress further the efforts initiated by this Expert Consultation towards developing a harmonized plant pest management curriculum for the region.

In preparing this compilation, we wish to take the opportunity to acknowledge the contributions and help of the following:

- FAO-RAP for organizing and sponsoring the Expert Consultation.
- Support staff of FAO-RAP for secretarial and miscellaneous help during the Expert Consultation.
- The participating experts for paper presentations and/or inputs during the Expert Consultation.
- Mr. W.K. Lum (CABI-SEARC) for miscellaneous help in the paper compilation.
- Many other individuals who have given specific or general help in one way or another during the Expert Consultation and/or preparation of this Proceedings.

December 26, 2000 Editors

ACRONYMS AND ABBREVIATIONS

AAU	Anhui Agricultural University, China
ADG	Assistant Director-General
AEA	Agriculture Extension Academy, Indonesia
AESA	Agroecosystem Analysis
AFTA	ASEAN Free Trade Area
AGRIS	AGRIS is the international information system for the agricultural sciences and technology. The system identifies worldwide literature (both conventional and non-conventional; the so-called “grey” literature), dealing with all aspects of agriculture.
AIADP	Antique Integrated Area Development Programme, Philippines
APT	Agricultural Production Technician
ARF	Action Research Facility
ASC	Australian Studies Center, Thailand
ASEAN	Association of South East Asian Nations
BAU	Beijing Agricultural University, China
BPI	Bureau of Plant Industry, Philippines
BPH	Brown planthopper
BSU	Benguet State University, Philippines
CABI	CAB *International*
CABI-IIBC	CABI International Institute of Biological Control
CABI-SEARC	CABI-South East Asia Regional Centre, Malaysia
CABPESTCD	CABPESTCD is a quarterly CD-ROM database taken from CAB ABSTRACTS and covers all aspects of crop protection.
CAU	China Agricultural University (in China) or Central Agriculture University (in India)
CBD	Convention on Biological Diversity
CPD	Crop Protection Division, Philippines
CPPQD	Crop Protection and Plant Quarantine Division, Malaysia
DA	Department of Agriculture, Philippines
DOA	Department of Agriculture (Malaysia or Thailand)
DOAE	Department of Agriculture Extension, Thailand
DSS	Decision Support System
EIL	Economic injury level
ETL	Economic threshold level
FAO	Food and Agriculture Organization of the United Nations
FAO-IPC Rice	FAO Intercountry Programme for Integrated Pest Control in Rice in South and Southeast Asia
FAO-RAP	FAO Regional Office for Asia and the Pacific, Bangkok, Thailand
FFL	Farmers and Farmer-Leader
FFS	Farmer Field School
FFFS	Follow-up Farmer Field Studies
FL I	Field Leader I
FL II	Field Leader II
FTC	Farmer Training Centers, Malaysia
FTF	Farmer Training Facility
GIS	Geographic Information System
GMO	Genetically Modified Organisms
GMU	Gadjah Mada University, Indonesia
GTZ	Deutsche Gesellschaft fur Technische Zusammenabeit GmbH.
HNAU	Huanan Agricultural University, China
HRDD	Human Resource Development Division, Malaysia
IARI	Indian Agricultural Research Institute
IBP	Bogor Institute of Agriculture, Indonesia
ICAR	Indian Council of Agricultural Research

IPC	Integrated Pest Control
IPM	Integrated Pest Management
IRRI	International Rice Research Institute, Philippines
ISM	Integrated Soil Management
JAU	Jiangxi Agricultural University, China
KASAKALIKASAN	*Kasagaanna ng Sakaban At Kalikasan*, Philippines
KAP	Knowledge, attitude and practice
KU	Kasetsart University, Thailand
LGU	Local Government Unit
MARDI	Malaysian Agricultural Research & Dvelopment Institute
MEVET	Municipal Experts and Village Extension Trainer
MPOB	Malaysian Palm Oil Board
MRB	Malaysian Rubber Board
NAU	Nanjing Agricultural University, China
NCPC	National Crop Protection Center, Philippines
NFE	Non-Formal Education
NGO	Non-Government Organisation
NPPTI	National Plant Protection Training Institute, Hyderabad, India
NT	National Trainer
PD	Presidential Decree
PhilRice	Philippine Rice Research Institute
PPMC	Plant Pest Management Curriculum
PPMCD	Plant Pest Management Curriculum Development
PTD	Participatory Technology Development
POT	Package of Technology
PRA	Pest Risk Analysis
RAWEP	Rural Agricultural Work Experience Programme, India
RCPC	Regional Crop Protection Center, Philippines
RES	Research and Extension Specialist
RETDC	Regional Extension Training and Development Centers, Malaysia
Rp	Rupiah (Indonesian)
RR	Regional Representative
Rs	Rupees (Indian)
SAU	State Agriculture University, India
SDOA	State Department of Agriculture, Malaysia
SEWS	Surveillance and Early Warning System
SMS	Subject Matter Specialist
TFT	Training-of-Farmer Trainers
TOS	Training-of-Specialists
TOT	Training-of-Trainers
T&V	Training and Visit
UKM	University Kebangsaan Malaysia (or the National University)
UM	University of Malaya
UPLB	University of the Philippines at Los Baños
UPM	University Putra Malaysia (formerly known as University Pertanian Malaysa)
UNCED	United Nations Conference on Environment and Development
USM	University Sains Malaysia or the Science University of Malaysia (in the case of Malaysia), or University of Southern Mindanao (in the case of the Philippines)
WBPH	Whitebacked Planthoppers
WEX	Work Experience, India
WG	Working Group
WTO	World Trade Organization
YUAC	Agricultural Colleges of Yangzhou University, China
ZUAC	Zhejiang University Agricultural College, China

OPENING ADDRESS

Dr. R.B. SINGH
FAO Assistant Director-General and Regional Representative for Asia and the Pacific
Mr. Chairman
Distinguished Experts and

FAO Colleagues:

On behalf of the Director-General of FAO, Dr. Jacques Diouf, and on my own behalf, I extend to you a warm welcome to this "Expert Consultation on Plant Pest Management Curriculum Development for University and Related Institute Education in Asia-Pacific". I am delighted that as many as 13 experts from seven Asian countries, one international institute, one NGO and FAO IPM project are participating in this Consultation.

As you know, the Asia-Pacific Region encompassing 36 countries, accounts for 57 percent of the world's population but has access to only 31 percent of the world's arable land. It houses 73 percent of the world's farming households and is the leading producer of several major crops. Hence, events in the Asia and Pacific Region would significantly influence the pace and direction of world agriculture.

As compared to the rest of the world, the Region is handicapped in the per caput availability of land, water and other resources. For instance, per capita land availability in this Region is about $1/6^{th}$ of that in the rest of the world. There are limitations in bringing new areas under cultivation. In fact, many of them have already serious problems of diminishing soil fertility arising from cultivation of marginal lands. Given the projections of population growth and food demand, and land availability in the future, the Region must produce more and more from ever shrinking land and other agricultural production resources. While most countries in the Region have recorded fairly satisfactory progress in crop production, there are still quite a few countries where the food crop production growth rate is unsatisfactory. In most countries of the Region, the future strategy of crop production must lay greater emphasis on increase in production per unit area of existing crop lands instead of horizontal expansion. This calls for greater efficiency and cost effectiveness in the crop production system.

Agricultural intensification ushered primarily through the Green Revolution in the Region is fraught with the increasing incidence of pests and use of chemical pesticides, and the resultant pollution and environmental degradation. The problem gets further compounded ecologically, economically, socially, and environmentally in tropical and sub-tropical developing countries with high concentration of small farmers.

The estimates of pre- and post-harvest crop losses vary from 20 to 50 percent. We must recognise that a grain saved is a grain produced. The losses are due to several causal organisms - insects, diseases (bacterial, fungal, viral), weeds and vertebrates. Often the damages caused by these veritable agents are not independent of each other. Therefore, the inter-disciplinarity assumes high importance.

In this new century and millennium, several other considerations also assume high importance in designing pest management programmes, including curriculum development. Biotechnology is already playing a leading role in the management of insect pests, diseases and weeds through the development of transgenics. Through the pyramiding of resistance genes by genetic engineering methods, crop varieties possessing multiple resistance to multiple adversities are being developed. This frontline breakthrough has raised new questions of biosafety, quarantine, bioregulations and international sharing of genetically modified organisms. With the increasing emphasis on organic agriculture, there will be greater accent on bioagents, biopesticides, and bioregulators. Individual countries and international systems will be called upon to develop appropriate national and international laws, rules and regulations, standards and codes to manage the pests and related problems. It is thus obvious that besides developing appropriate technology, such as transgenics, there is a need for comprehensive policy development on management of pests. So, I am pleased that FAO through its various IPM regional and national projects has been developing human resources to address the technological as well as the enabling processes.

It is heartening to note that the national and international programmes in the Region had taken note of the above developments and are in process of making necessary adjustments and creating new structures to meet the challenges and opportunities. We in FAO feel that there is a need for creating greater awareness at various levels for development of well-rounded human resources for managing plant pests. They must have full appreciation of not only the science and technology of pest management but also of the several non-technological dimensions. In other words, we need a new breed of human resource for pest management. We have universities in the West, such as the Wageningen University and Research Centre in the Netherlands, preparing graduates with interdisciplinary background for pest management. We also have universities in the developing Asia-Pacific Region doing similar tasks, such as the Plant Protection College of the China Agricultural University, Beijing, and the School of Plant Protection and the National Centre for Integrated Pest Management of the Indian Agricultural Research Institute, New Delhi. A new concept of Farmer Field School has been created through the various FAO IPM projects.

Notwithstanding the above initiatives, we have a long way to go in institutionalising human resource development for plant protection in a comprehensive manner. The distinguished experts present at this Consultation in their deliberations may wish to keep in mind that a curriculum for formal or non-formal education in pest management must have elements of inter-disciplinarity, integration, partnership and participatory approaches. It must cover topics/courses related to pest management policies, economics, trade, social dimension, biotechnology for pest management, informatics for pest management and Decision Support System (DSS). The curriculum must also include risk assessment analysis and risk management options. An understanding of Geographic Information System (GIS), remote sensing and climatology would be necessary. Comprehensive coverage of regulatory aspects and international codes in relation to biosafety and pest management should be ensured.

It is obvious that curriculum developers cannot work in isolation, but need to take into account the views of a wide range of plant pest management professionals, managers, policy makers, etc. There should be a harmonized core curriculum development of plant pest management education at graduate and post-graduate levels in the Region. Curriculum should be given more of a future orientation within particular agro-environment, cultural, and socio-economic condition. In the design and development of curriculum, developers should take account of and selectively utilise existing systems. However, it should be kept in mind by the curriculum developers that the future of plant pest management would not be entirely new but would evolve out of the present system.

Curriculum developers should be open to the farmers' needs and expressions and see themselves as collaborating with the work of other related national and international agencies, as well as, taking note of community issues, in order to avoid duplication and waste of needful resources. In the course of revision of the curriculum, teachers' guides, manuals, etc., it should bear in mind to prioritise the feedback from field extension output, particularly the experiences of the graduates and post-graduates in the service. Curriculum design and development should take into consideration not only national needs but the need for greater international understanding as well.

I understand that all the experts are here for four days to discuss how to integrate the relevant major subject areas to fit into the curriculum of regular graduate and post-graduate education in plant pest management. So far, it is observed that there is a wider variation of higher education in plant pest management among the countries of the Asia and Pacific Region. In fact, while the Region has very successful integrated plant pest management accomplishment to its credit, much more remains to be done particularly in the area of higher education in this field.

I wish to urge the Consultation to also ponder over the following issues:

- Should an interdisciplinary curriculum be prepared only for undergraduates or should similar courses be taught also at M.Sc. and Ph.D levels? The employment ability of such graduates should be examined vis-à-vis the employment opportunities in specialty fields, such as entomology, pathology, virology, microbiology, etc.
- The availability of competent teachers to handle the proposed curriculum.
- The possibility of creating various modules of pest management training at formal and non-formal levels.
- Changed concept of practical training, including Farmer Field School, the curriculum for extension agents.
- How many institutions in a country should produce how many graduates under the banner of pest management? Is there a need for creating a regional institution for granting M.Sc. and Ph.D degrees in pest management (integrated)?
- The possibility of a regional mechanism to harmonize the curriculum and training needs and to manage it in a dynamic manner.

In conclusion, I would like to extend once again a very cordial welcome to you all. I have no doubt that with the participation of the distinguished experts, this will be a highly productive Consultation. However, as the saying goes “the proof of the pudding is in the eating”, so the efficacy and relevance of plant pest management educational programmes can best be determined in the learning situation. So, the systematic try-out and formative evaluation in actual learning-teaching situations would be of paramount importance. Your careful recommendations will receive due attention of FAO and the Organization will strive to ensure their effective and timely implementation.

I wish you a very successful Consultation.

PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT FOR UNIVERSITY AND RELATED INSTITUTE EDUCATION IN ASIA-PACIFIC

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ABSTRACT

A sound curriculum in plant pest management is necessary to produce quality human resource needed for effective implementation of pest management activities. For the Bachelor degree, the curriculum should aim at providing a general and basic plant pest management education with expertise to handle a general range of roles that can fit in with most plant protection functions (extension, research, the agricultural industry, etc). However, at the higher degree levels, there will be need for more in-depth and specialised training and also a wider coverage of subjects.

The bulk of the curriculum should comprise of basic/core subjects to provide the basic foundation in plant protection within the agricultural science. Among these, IPM warrants a comprehensive treatment as the central theme in plant pest management. The newer approach of farmer participatory training and research should receive key consideration. Besides the core subjects, other current and general issues (e.g. globalisation, free trade, etc) that can affect plant pest management must also be included. Incorporating practical farm training (20–30%) would enable trainees to better handle the problems normally encountered by growers. Trainees also need to undertake a project assignment resulting in a dissertation.

Presently, there exists great variations in the pest management curricula in the Asia-Pacific region and there is need to harmonize them because of many potential benefits. Initially, only important subjects common to all the Bachelor degree curricula for pest management in the different countries need be retained. To these should be added other new and common aspects to form the core curriculum. Specific aspects peculiar for a particular country can then be included to this core curriculum to form the overall (combined) curriculum to be used in the country concerned. From time to time, the curriculum will need to be improved/revised to include future developments. Further regional consultations may be needed for this and to maintain a harmonized plant pest management curriculum.

INTRODUCTION

Agriculture plays an important role in most developing countries in the Asia-Pacific region. In crop production, the management of pests (broadly defined to include all agents, such as insects, diseases, weeds, rodents, etc) forms a crucial aspect that demands special attention. Among the control tactics used, pesticides have taken a frontline in many countries in the region during the recent decades. This has resulted in a number of serious and undesirable problems, giving rise to concerns over many issues relating to pesticides and their adverse affects on pest ecology, the environment and human health. It has also propelled the development and acceptance of Integrated Pest Management (IPM) as an alternative option in pest management for the region. IPM has thus become an important approach and is central to the practice of plant pest management.

For successful development, promotion and effective implementation of plant pest programmes, in particular IPM, a number of attributes must be in place, *viz*: existence of a good and positive policy support, appropriate infrastructure in plant protection institutions, relevant research programmes, good extension support and adequate human resource capacity. For the latter, having a sound curriculum is especially important since it will determine the quality of the human resource responsible for implementing the plant pest management activities. Consequently, it will also influence the success potential of any plant pest management programmes that a particular country plans to implement. Thus, developing a sound curriculum becomes crucial in any human resource development programme for plant pest management. This paper focuses on the guiding principles in formulating the plant pest management curriculum for university and related institute education which, hopefully, will stimulate future development towards a plant pest curriculum that is broadly acceptable and appropriate for the Asia-Pacific region.

FUNDAMENTALS OF THE CURRICULUM

Subject Matters

What would constitute the contents in a plant pest management curriculum is largely governed by a number of considerations, such as:

- Overall/specific objectives of the plant pest programmes to be undertaken.
- Types/roles of course participants (researchers, farm extension workers, etc).
- Level of plant pest expertise required.
- Current level of development in plant pest activities in a location/country/region.
- General plant protection issues faced currently.
- Duration of the course.
- Others (e.g. specific pest problems, extent and nature, etc).

The focus here will largely target plant pest management curriculum for university level education. It aims at providing a general and basic plant pest education with expertise to handle a general range of roles that can fit in with most plant protection functions, such as, extension, research, the agricultural industry, etc. Essentially, the training will be equivalent to the level of a basic or Bachelor degree. Thus, it will not provide the specialization needed for more specific roles, where follow-up and more specialized training will be required by way of higher degrees or specialized courses.

The curriculum would focus mainly on the fundamental aspects that serve to provide a sound foundation in plant pest management to the trainees. It is recognized that many other aspects will need to be added to cater for specific needs of different locations or regions. However, the guiding principles suggested below will provide for only the core or basic curriculum. Only crucial and essential aspects are considered and they constitute the fundamentals that must at least be included in all plant pest management curricula. Together, these aspects will form the core curriculum that provides a sound foundation for graduates to perform or pursue further their respective areas of interest relating to plant pest management. The following are key subject matters that the curriculum should consider for incorporation:

1. Basics of the following subjects

1.1.1 Agriculture Zoology
1.1.2 General Botany
1.1.3 Agriculture Economics
1.1.4 Entomology (including mites and other arthropods)
1.1.5 Plant Pathology (including nematodes and other microbes)
1.1.6 Weed Science
1.1.7 Vertebrate Pests
1.1.8 General Crop Production/Agronomy

A sound knowledge in the above basic aspects is desirable as they provide the broad-based understanding in support of plant pest management. A good foundation in these aspects is essential for developing the needed expertise required, as well as for any further specialisation needed subsequently.

2. Principles of ecology

1.1.1 Insect Population Dynamics
1.1.2 Epidemiology of Plant Diseases
1.1.3 Weed Ecology

Maintaining appropriate ecological balance of plant-pest-natural control is the key to a sound pest management programme. Failing to appreciate this has resulted mainly in short-term management measures which in turn have led to most of the pest problems continuing to remain so, sometimes even becoming worse. There is therefore no sustainable and long-term impact/benefits being achieved. Incorporating this aspect into the curriculum to ensure that the principles of ecology are well understood is therefore crucial.

2. Ecological methods, diagnostic procedures and pest identification

Accurate assessment methods are necessary to determine the situation of a pest and its natural control in the field, particularly in ecological studies and other scientific experiments and investigations. Sometimes, they are also needed during pest outbreaks to assist decision-making in management operations. Many methods have been developed for different pests and for different crop ecosystems and conditions. These include procedures on both absolute and relative estimates. Examples include visual assessments, sampling with various kinds of traps (aerial suction trap, sticky trap, pitfall trap, others), marked-recapture technique (painting, clipping, others), sweep net, heat extractor, etc. All these should form an important part of the plant pest management curriculum so that course participants can become familiar with the methods and are able to deploy them when required, including analysis of the sampled data. To do this effectively, they should also be sufficiently familiar with basic diagnostic procedures and be able to identify the pests and other associated organisms.

4. Plant breeding and genetics

Plant resistance constitutes an important means of plant pest management. A basic understanding of plant breeding and genetics therefore can help in a fuller appreciation towards the use of plant resistance approach in managing pests, including how it may be integrated with other control methods.

5. Chemical pesticides and related issues

Because of the heavy reliance and excessive use (including misuse) of chemical pesticides, many undesirable and associated problems have now been encountered. It is crucial that those involved with plant pest management must become fully aware of these problems and the related issues so that they can help to deal with them accordingly, either in avoiding or minimizing their negative impacts wherever possible. Some general issues that they need to know would include at least the history on the development and use of pesticides, pesticide toxicology and related health hazards, and the ecological and environmental impacts, including their concerns and management. More specific aspects for inclusion, among others, are the types and nature of pesticides (including their modes of action, toxicity pathways, etc); pesticide evaluation and other bioassay techniques; resistance mechanisms and development; effects/impacts of pesticides on natural enemies; pesticide application technology; and pesticide regulations and the registration requirements.

6. Methods of pest control

Different approaches or control tactics are available for combating the wide range of crop pests. The major ones include biological control and other bio-based products, plant resistance, cultural practices, physical/mechanical means, chemical control, and various traditional methods. Knowing these and how they function will help in making the appropriate tactical choices for formulating the required pest management strategy for a particular situation. That course participants must know about the different approaches or tactics cannot be over-emphasized. These aspects, therefore, must form an important part of the plant pest management curriculum.

7. Plant Quarantine

Quarantine forms the frontline in plant pest management, particularly in preventing unwanted entry of a new pest organism. Understanding how quarantine operates, including the various quarantine rules and regulations, the quarantine procedures, pest risks assessment, and other related quarantine matters, is thus an important requirement. This need has become even more important in recent years and is likely to increase in the future. The main reason for this is because the risk from accidental introduction of an exotic pest has increased significantly, due mainly to more rapid and frequent inter-country movements of people and materials as a result of increased tourism and more trading activities. The latter is largely due to globalization in trade arising from agreements under the World Trade Organization (WTO) and the ASEAN Free Trade Area (AFTA). The plant pest management curriculum cannot ignore these issues and must therefore include the aspect of plant quarantine.

8. Principles/methods of pest surveillance and forecasting

Pest surveillance and forecasting have form part of plant pest management in many countries of the region. A variety of methods and devices are being used, such as, visual assessment methods, using spore trap for fungal agents, setting up pheromone and light traps for some insects, etc. Those involved with plant pest management therefore should be knowledgeable in the principles and methods of pest surveillance and forecasting, including their operations, data gathering and data analysis. Hence, these aspects need to be incorporated into the plant pest management curriculum.

9. Integrated pest management

Since IPM is now the central theme in plant pest management and has good prospect to overcome many of the undesirable concerns of pesticides, it is crucial that a comprehensive treatment of this subject must be given in the curriculum. It must include the full range of studies relating to IPM, right from the basics (e.g. historical development, rationale and principles of IPM, management tactics and their strategic application, operational aspect on implementation, etc) to more comprehensive issues on policies, institutional structures and human resource development, project development and funding. In particular, special attention must be given to its wide-scale implementation and operational strategies, drawing on the lessons learnt from past failures and recent success cases. The newer approach, involving farmer participatory training and research, should receive key consideration in the curriculum.

10. Major crop ecosystems and the key pests

Since those who are involved in plant pest management will need to deal with the major pests of crops, the curriculum should include relevant studies of these pests in the major crop ecosystems. Although some of these may vary in different countries, the majority will be common over the region. The curriculum should expose the trainees to at least the major ones.

11. Biotechnology

Biotechnology has recently emerged to become an important science that will have an increasing impact on plant pest management. Thus, there should be sufficient coverage given to this subject, especially the basics of biotechnology and how this new science relates to plant pest management. In particular, the various controversial issues around biotechnology should be carefully examined and understood. Whatever potential benefits to be derived and any contribution that could help improve plant pest management must be weighed against any negative impacts (real or potential) that may arise.

12. Extension methodology

Unless there is effective extension of research technology, much of the latter will remain within the academic domain and few of the target clienteles can actually benefit from the knowledge that are generated to improve plant pest management. Course participants, therefore, should be made fully aware of this. The curriculum should expose them to the different extension methods so that they can be applied accordingly where required. It should be noted that a highly successful and proven method is that relating to the farmer participatory approach. Thus, all those who are involved in plant pest management should be guided on this aspect.

13. Statistical methods and analysis

These are basic requirements in all scientific curricula. The science of plant pest management therefore is no exception and their importance within the curriculum should not be overlooked.

14. Computer applications and bio-informatics

With the advent of computers and related information technology, there has been revolutionary changes in information access today, including in the field of plant pest management. The information age has made available easier and quicker access of plant pest management information through huge and interactive databases captured in compact discs. Some examples include the CABPESTCD, Global Crop Protection Compendium, Arthropod Name Index, AGRIS, etc. In addition, various kinds of information relating to plant pest management are also obtainable through the global Internet facilities. Awareness of such facilities and the ability to use them are of enormous advantage to the course participants. Computer applications and the field of bio-informatics should therefore form a necessary requirement in the curriculum of plant pest management.

15. General/current issues of concern to plant pest management

There are many general issues of concerned to plant pest management which course participants should be aware of. These are broad subjects that may impact on general perspective of plant pest management; hence they may shape decision-making and other follow-up actions of those involved. Some aspects, among others, are those relating to globalization and trade agreements of WTO and AFTA, the action plans of UNCED Agenda 21 and Convention of Biological Diversity (CBD), and the import regulations under the FAO Code of Conduct for the Import and Release of Exotic Biological Control Agents. Others are biotechnology and plant pest management, alternative agriculture (e.g. organic farming, sustainable agriculture, etc) and those relating to global invasive species. Course participants should be encouraged to take interest in them and to ponder and discuss such agriculture-related issues through the curriculum.

Practical Field Work

It is important to note that plant pest management deals substantially with field problems. Although certain amount of formal lectures and laboratory experimentation will be required to gain the general understanding and specific technical skills, these are essentially to provide the basic backup knowledge for operational exercises and decision-making in the field. Thus, it is essential that a substantial amount of practical training in the field (20–30%) must form part of the plant pest management curriculum to supplement the lectures and laboratory activities. This will ensure that course participants do not remain confined to a purely academic domain or only with theoretical knowledge but can also develop to become one with a practical outlook in plant pest management. The practical work out in the farm will allow them to experience the realities of pest problems and also other production constraints normally encountered by growers.

It cannot be over-emphasized that no amount of book learning and lectures can match the benefits to be derived from a combination of lectures and direct/personal learning through self-discovery in hands-on activities in the field. Of especial importance is that the practical field work will help develop the right kind of graduate with the proper balance of education around plant pest management

Projects and Dissertation

Unlike the practical field activities which essentially are smaller bits of studies or exercises with objectives to elucidate certain specific issues in isolation, the projects to be undertaken (and which will result in the preparation of project reports or dissertations) are targeted at much broader themes that encompass a number of smaller but related issues. Each project assignment could be of at least 6-month duration and is to be carried out in the final year.

The prime value of such a project assignment is that the trainee will have the opportunity to apply independently the knowledge he/she has acquired so far to a current problem and thereby is able to exercise and demonstrate his/her scientific capability. Developing the confidence in solving a plant pest problem would be another major benefit. In addition, there is the opportunity to display his/her initiative, organising and management ability, and the resourcefulness in finding the best means to meet the challenges of the project assignment within a time period. The project report would permit the assessment of the work outputs, including the trainee's coherence of thoughts in the assigned subject, analytical capability and presentation skills.

DISCUSSION

Many countries in Asia-Pacific have a plant pest management curriculum in one form or another. They are however dissimilar in some ways in the different countries because of (i) unequal priorities accorded to different crops and the pest problems, (ii) different emphasis given to certain technical aspects due to different levels in plant protection science, (iii) differing funding support, and (iv) availability of resource capacity. It is desirable that whatever differences currently exist be reduced so that a more uniform curriculum can be applied within the region. This will have the advantage in producing graduates of similar training, capability and appreciation in plant protection science that will allow for easier knowledge sharing, exchange of expertise and mutual inter-country assistance within the region. Such a development will have great significance since the region faces many common pest problems. Moreover, this need may become more critical with increasing global competition due to more open market and demand for better quality in agricultural food produce.

It is acknowledged that whatever efforts made to narrow the differences among the current curricula of plant pest management in the region towards a more uniform curriculum may not be easy or can be achieved quickly. This is because many diverse factors and conditions need to be given consideration, mostly those that give rise to the current differences, and some of which may even be outside the jurisdiction of plant protection authorities. Ultimately, after a series of consultations, the basic curriculum must be formulated, agreed to and accepted by all the parties concerned. Despite the daunting task ahead, it is necessary to make a start, and this Expert Consultation has provided the initial opportunity. Hopefully, this beginning will stimulate and expedite the process to achieve the goal of harmonizing the various curricula.

As a start it is suggested that the plant pest management curriculum for the basic degree in the different countries be first examined for areas of commonality. The rationale for retaining each particular subject in the curriculum should be carefully considered. This should be followed by consideration of other new and additional aspects for incorporation into the plant pest management curriculum. All these subjects agreed upon will then form the core of the curriculum for the basic degree for the region. Specific aspects peculiar for a particular country can then be added to this core curriculum to form the overall (combined) curriculum to be used in the country concerned. For all these core subject areas identified, it is necessary also to develop the sub-topics. For example, the sub-topics of basic entomology (and other core subject areas) must be clearly spelt out, such as, insect taxonomy and classification, insect morphology, insect biology, insect physiology, insect behaviour, etc.

This plant pest management curriculum is not cast-bound. Over time, it will need to be improved or revised to fit in with any future developments or other changes. There may be additions, deletions, or both, that have to be done to the curriculum; these depending on what the conditions may then be at that point of time. Thus, a review of the curriculum will have to be carried out from time to time so that the appropriate actions can be taken.

It is recognized that the desired plant pest management curriculum for the basic degree will require more than just this single Expert Consultation before it can be finalized and accepted by all concerned. It cannot be over-emphasized that the quality of the curriculum must not be compromised in order to have it completed speedily. Achieving a curriculum of quality is crucial because it must provide a good foundation in plant protection science to the graduates. Only with a good foundation can they perform effectively in the crop protection tasks (required immediately of them if they proceed straight into employment) or to continue their studies further for higher degrees to specialize in some selected pest control disciplines.

The above guidelines are suggested for developing only the core curriculum of the basic degree in plant pest management. Using this as the base, the subjects identified so far, (and along with other additional ones), can be given greater depths in treatment to fulfill the requirements for subsequent higher degrees in plant pest management. Besides the greater depths in subject treatment, the curricula for the higher degrees would also need to enlarge on their range of subject coverage, include special pest management issues that require critical analyses, run more practical field work and demand a more comprehensive dissertation on research of longer duration.

An important area for expansion in the curricula of the higher degrees is that of IPM. This is mainly because IPM has emerged as the central theme in plant pest management. Furthermore, the demand for IPM will increase because of its bright prospect. Firstly, the benefits are enormous. Also, more and more successes are being achieved at farm level and in an increasing number of different crops in the region. The science of IPM is improving while the constraints to field implementation are better understood. Consequently, the adoption and diffusion of IPM has increased much more rapidly in recent years. In addition, national governments and many non-governmental organizations and aid-agencies have shown keen interest in IPM and have increased their support. Thus, IPM will likely assume a much greater importance in the future, and as such, IPM must feature prominently in any plant pest management curricula.

It is important to note that although this Expert Consultation deals mainly with plant pest management curriculum for university and related institute education, we do not forget one other important and very successful group of IPM practitioners in plant pest management. This group includes a wide range of people; some with degree education (extension scientists), many more with college level education (extension field workers and technicians) and very large numbers without any formal education (the farmers). Many in this group have proven to be good IPM practitioners at farm level after undergoing training in IPM through the non-formal and participatory approach, one model of which is that of Farmer Field Schools. A different curriculum is followed here, though still with room for improvements on its technical contents. However, because of the high success rate achieved by this IPM group, the university education should also include studying the group's approach in its plant pest management curriculum. An understanding into this may possibly help the university improve its teaching approach, particularly in IPM. In addition, it could provide an opportunity for the course participants to understand better the IPM group training approach and possibly enable the graduates to help improve further the curriculum (technical) contents currently in use by the IPM group.

III. Country Statement

PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT IN NANJING AGRICULTURAL UNIVERSITY OF CHINA

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ABSTRACT

The Plant Pest Management Curriculum (PPMC) for undergraduate programme in Nanjing Agricultural University (NAU) underwent great changes with the progress of science and technology development. Initially, only few basic and specialized courses were offered. Since 1980 and because of the introduction of more advanced technologies from western developed countries to help modernize the agriculture industry in China, the curricula were improved to enable students to master more knowledge. From 1990 onwards, the Master and Ph.D degree programmes expanded rapidly. The main curriculum reform was to reduce the common basic courses, and instead, add key specialized courses and to emphasize the importance of practical skills. Students of Plant Production (majoring in Agronomy, Horticulture, Pedology (Soil Science), Plant Protection, and others) are required to undertake several specialized and basic courses in their respective areas of specialization. For Plant Protection, the five basic courses are Fundamental Entomology, Agricultural Entomology, Fundamental Plant Pathology, Agricultural Plant Pathology and Plant Protection (using pesticides). In addition, students must take other selective courses, and practical work is considered particularly important.

Besides NAU, there are many other agricultural institutions in southern China. In general, the curricula for Pest Management in undergraduate programmes in these institutions are similar. The main difference is usually only in the selective courses. The practical training is also somewhat similar, except it may differ in duration.

INTRODUCTION

Nanjing Agricultural University (NAU), directly administered by the Ministry of Education (formerly by both Ministry of Agriculture and Ministry of Education) of China, is a key national university of higher learning and is one of the earliest higher education establishment of agriculture in China. It enjoys a good reputation both at home and abroad.

Its predecessors were two agricultural colleges belonging to Jinling University (Catholic, established in 1914) and the Central University (state-run, established in 1915), respectively. In 1952, the Nanjing Agricultural College was created as a result of the unification of these two colleges, together with some departments of the Agricultural College of Zhejiang University. In 1984, the college was renamed as Nanjing Agricultural University to reflect the wide-ranging disciplines it offers and the strong position it holds in China.

After a long period of development, NAU, with a total staff of 2,500 and current student enrollment of more than 10,000, has grown into a high level establishment of agricultural education with wide-ranging disciplines and high academic standards. According to the main indexes of the Ministry of Education, NAU is a leading agricultural institution among all others in China. Since 1990s, NAU has been among the top 45 higher education establishments and is one of the top two agricultural institutions in the country. With rapid growth and changes in China's economic conditions, NAU realizes the importance of adjusting its disciplines to meet the needs of the social and economic development. As a result, NAU founded ten colleges, namely, College of Agriculture, College of Resources and Environmental Sciences, College of Animal Sciences and Technology (including the College of Fishery), College of Animal Medicine, College of Agricultural Engineering (including the College of Township Enterprises), College of Economics and Trade, College of Food Sciences and Technology, College of Land Management, College of Sciences and College of Humanities and Social Sciences. There are four key scientific disciplines nominated by the Ministry of Education, six key disciplines nominated by the Ministry of Agriculture and five key disciplines nominated by Jiangsu Province. Two post-doctorate programmes, 19 Ph.D. programmes and 40 Master programmes offered by these colleges cover five inter-disciplines of agronomy, engineering, economics, sciences and the arts. Having agronomy as the dominant field, a new structure was formed to integrate the development of agriculture, engineering, economics and the arts. In addition to the ten colleges, NAU also has a Graduate School, a College of Adult Education, an Experimental Farm and an Experimental Stock Farm to facilitate its teaching and outreach programmes. While a new structure was being established, the curriculum underwent major reform to meet the needs of the society under the new economic system in China.

In 1952 when the Nanjing Agricultural College was established, the Department of Pest Management was founded by combining the Department of Pest Management of Central University, the Division of Plant Pathology and the Division of Entomology of Jinling University. It was renamed as the Department of Plant Protection in 1954. Today, the department offers two Ph.D. programmes, two Master programmes (Plant Pathology and Entomology) and one undergraduate (Bachelor) programme (Plant Protection). This paper focuses on the reform of the curriculum for undergraduate programmes of Plant Protection (Pest Management) in NAU and in other institutions of Southern China.

HISTORY OF PLANT PEST MANAGEMENT CURRICULUM

The curriculum for pest management underwent great changes as the science and technology developed. In the early days, when the department had just been established, there were only a few basic courses and specialized courses for undergraduate programme of Plant Protection (or Plant Pest Management) (Table 1). Common basic courses included Language (15 credits, including English, Chinese Literature), Fundamental Sciences (23 credits), Social Sciences (8 credits) and Applied Sciences (18 credits). Required specialized courses (32 credits) included Entomology (Fundamental Entomology, Economic Entomology, Insect Taxonomy, Insect Morphology, Insect Ecology, Apiculture, etc.), Plant Pathology, Bacteriology, Mycology, Plant Physiology, Plant Cytology, Plant Histology, Crop Genetics, Crop Breeding and Pest Control, etc. There was also a Special Practice (2 credits). Students had to write a dissertation before graduation. In essence, the curriculum during that period was rather incomplete.

Since 1980s, due to the open-door policy of China, more advanced technologies were imported from western developed countries to serve the modernization of China's agriculture and industry. This resulted in the modification of the curriculum in agricultural institutions in China to enable students to master more knowledge. In NAU, more selective courses were added to the curriculum to broaden their range of knowledge, except the compulsory common basic courses (69 credits) which included History, Philosophy, Physical Exercise, Law, Inorganic Chemistry, Organic Chemistry, Analytical Chemistry, Higher Mathematics, Application of Computer, Computer Language, etc. (Table 2).

Table 1. Main specialized courses for undergraduate programme of Pest Management from 1940s to 1970s in Nanjing Agricultural University, China.

Specialized Courses	Credits	Specialized Courses	Credits
Plant Physiology	3	Fundamental Entomology	3
Plant Cytology	3	Insect Taxonomy	3
Plant Histology	3	Insect Morphology	3
Crop Genetics	4	Insect Ecology	3
Bacteriology	3	Pest Control	3
Mycology	4	Economic Entomology	3
Plant Pathology	4	Apiculture	3
Discussion on Entomology	2	Design of Practice	2
Dissertation	2	**Total**	**51**

This new curriculum emphasized a broad knowledge base. Students had more choices to acquire different kinds of knowledge based on their own interests by selecting various courses. However, there were still some disadvantages in the curriculum. It has not paid sufficient attention to the students' practice. Students did not have enough time for practical work and this led to students who graduated with the knowledge of basic principles but little practical experience. This therefore prompted further reform in the curriculum to the one being currently used.

Table 2. Main specialized courses for undergraduate programme of Pest Management during 1980s in Nanjing Agricultural University, China.

Compulsory Specialized Courses	Credits	Selective Specialized Courses	Credits
Fundamental Biochemistry	5	Mycology	3
Botany	4	Insect Taxonomy	3
Fundamental Zoology	3	Study on Mites in Agriculture	3
Plant Physiology	4	Plant Quarantine	3
Fundamental Microbiology	3	Pathology of Economic crop	3
Crop Breeding	3	Integrated Pest Management	2
Crop Cultivation	4	Epidemiology of Plant Diseases	1
Genetics	4	Breeding for Plant Resistance to Diseases	1
Statistics and Field Tests	3	Biological Control of Plant Diseases	3
Fundamental Meteorology	2	Ecology and Forecasting of Harmful Insects	3
Fundamental Entomology	5	Resources of Insect	2
Fundamental Plant Pathology	5	Insects in Cities	2
Agricultural Plant Pathology	4	Processing and Management of Pesticides	3
Agricultural Entomology	4	Bioassay techniques of Insecticides	2
Plant Protection by Pesticides	5	Machinery of Plant Protection	3
Practice And Dissertation	3	Professional English	2
		Mice in Farm Fields	2
		Recognition and Control of Weeds	2
		Insect Pathology	2
		Insect Physiology	2
		Application of Computer in Plant Protection	2
Total	**57**		**49**

THE REFORM OF CURRICULUM

Since the 1990s, as a result of rapid growth of the Master and Ph.D. programmes, the education of undergraduate programme is now no longer the highest level of tertiary education in China. The purpose of undergraduate education has thus also changed accordingly. But, over the last several years, the old curriculum system had been adopted in most agricultural institutions in China. The main shortcoming of this curriculum system was the requirement of students to know a lot of the basic theory and principles. This has restricted them to book learning and become very narrow in their specific specializations. There is therefore a need to reform the curriculum to overcome this.

The primary guiding ideology for the curriculum reform was to reduce the ratio of the common and compulsory (or basic) courses to that of the key specialized courses and to give emphasis to the importance of practical work. The depth of coverage in the courses was decreased to a level equivalent to undergraduate programme training and also made significantly different from that of the graduate programme training. Every undergraduate student in NAU has to finish 894 academic hours (52 credits) of study in the common basic courses (Table 3). For all students of Plant Production, majoring in Agronomy, Plant Protection, Horticulture and Pedology (Soil Science), etc., it was imperative to take several related basic courses, such as Botany, Fundamental Zoology, Genetics, Crop Cultivation, Introductory Horticulture, Meteorology, etc. (Table 4). Students of Plant Protection must take five key specialised courses: Fundamental Entomology, Agricultural Entomology, Fundamental Plant Pathology, Agricultural Plant Pathology, and Plant Protection by Pesticides (Table 5). There are also more selective courses that cover a wider range of subjects for students to choose from, depending on their interests (Table 6). In addition, there are included various practicals of 21 to 27 weeks.

Table 3. Required common basic courses for undergraduate programme since 1998 in Nanjing Agricultural University, China.

Courses	**Credits**	**Academic Hours**	**Note**
History	3	54	
Philosophy	3	54	
Economy	3	54	
English	16	280	
Application of Computer (Internet)	2	36	
Computer Language	2	40	
Law	2	36	
Introductory Agronomy	2	36	
Physics	3	54	
Higher Mathematics I	4	72	Required
Higher Mathematics II	4	72	Selective
Fundamental Chemistry I	3	70	Required
Fundamental Chemistry II	2	40	Selective
Introduction to Management	2	36	
Organic Chemistry	3	72	
Physical Exercise	4		
Total	**52(58)**	**894(1006)**	

Table 4. Required basic courses for undergraduate programme specializing in Plant Production since 1998 in Nanjing Agricultural University, China.

Courses	Credits	Academic Hours	Note
Fundamental Zoology	2	36	
Fundamental Meteorology	2	48	
Introductory Horticulture	3	54	
Science of Soil and Fertilizer	3	54	
Botany	3	72	
Plant Physiology	3	72	
Fundamental Microbiology	3	72	
Genetics	3	72	
Statistics and Field Test Design	4	72	
Crop Cultivation	3	72	
Fundamental Biochemistry	4	90	
Total	**33**	**714**	

Table 5. Required key specialized courses for undergraduate programme of Plant Protection since 1998 in Nanjing Agricultural University, China.

Courses	Credits	Academic Hours	Note
Fundamental Entomology	4	90	Plus two weeks of practice
Agricultural Entomology	3	70	
Fundamental Plant Pathology	4	90	Plus two weeks of practice
Agricultural Plant Pathology	3	70	
Plant Protection by Pesticides	4	90	
Total	**18**	**410**	**4 (weeks of practice)**

Recently, NAU has revised substantially the curriculum of all undergraduate programmes for students enrolled in 1999. The newly-updated curriculum for plant pest management programme is divided into four different kinds (or levels). These are: (1) Required Basic Courses for all students of NAU; (2) Required Basic Courses for all students majoring in Plant Production; (3) Key Specialized Courses for Plant Pest Management (Plant Protection); and (4) Selective Specialized Courses for Plant Pest Management (Plant Protection). In general, there are no extensive modifications in the required basic courses for all students of NAU. The second group of courses emphasizes related areas that students should have some knowledge in (Table 7). The new curriculum retains the same five key specialized courses with a total of 23 credits and 414 academic hours. The academic hours for each selective courses are reduced to about 40 hours to make the courses smaller. Table 8 shows the revised selective specialized courses for undergraduate programme in Plant Protection. Meanwhile, small and practical courses are also added to the new curriculum (Table 9).

Table 6. Selective specialized courses for undergraduate programme of Plant Protection since 1998 in Nanjing Agricultural University, China.

Courses	Credits	Academic Hours
1. Principles and Methods of Pest Forecasting	3	54
2. Integrated Pest Management (IPM)	2	36
3. Epidemiology and Monitor of Plant Diseases	2	54
4. Extension of Plant Protection Techniques	2	36
5. Regulations and Law of Plant Quarantine	1	18
6. Techniques for Plant Quarantine	2	36
7. Plant Quarantine Insects	2	36
8. Plant Quarantine Pathogens and Weeds	2	36
9. Principles of Pesticides	3	54
10. Study of Pesticides	4	72
11. Processing and Management of Pesticides	3	54
12. Bioassay Techniques of Pesticides	2	36
13. Plant Pathogenic Fungi	2	36
14. Insect Taxonomy	2	36
15. Study on Mites in Agriculture	2	36
16. Pathology of Economic crop	2	36
17. Biological Control of Pests	2	36
18. Ecology of Harmful Insects	2	36
19. Resources of Insect	2	36
20. Insect in Cities	2	36
21. Machinery of Plant Protection	2	36
22. Professional English	2	36
23. Agricultural rat pests	2	36
24. Recognition and Control of Weeds	2	36
25. Insect Pathology	2	36
26. Insect Physiology	2	36
27. Statistics and Forecasting	2	36
28. Application of Computer in Plant Protection	2	36
29. Breeding for Plant Resistance to Diseases	2	36
30. Principles of Chemical Industry	2	36
31. Analysis of Pesticides	2	36
32. Biotechniques in Agriculture	2	36
33. Agricultural Environment Protection	2	36
34. Sustainable Agriculture	2	36
35. Organic Farming	2	36
36. Green Food Production	2	36
37. Diagnosis of Plant Diseases	2	36
38. Techniques of Plant Pathology	2	36
Total	**78**	**1422**

Table 7. Required Basic Courses to All Students of Plant Production Related Programmes in Nanjing Agricultural University, China.

Courses	Credits	Academic Hours
Botany	4	72
Plant Physiology	3	54
Laboratory Techniques of Plant Physiology	2	36
Fundamental Microbiology	3	54
Fundamental Biochemistry	5	90
Genetics	4	72
Biostatistics and Field Experiments	4	72
Fundamental Meteorology	3	54
Introduction to Crop Cultivation	3	54
Introduction to Horticulture	2	36
Introduction to Soils and Fertilizers	3	54
Total	**36**	**648**

Table 8. Selective specialized courses for undergraduate programme of Plant Protection in Nanjing Agricultural University, China (revised in 2000).

Courses	Credits	Academic Hours
1. Biological Control of Plant Diseases	1	18
2. Introduction to Molecular Plant Pathology	1	18
3. Agricultural Acarology	2	30
4. Biological Control of Insect Pests	2	30
5. Contamination and Ecology of Chemicals	2	30
6. Extension of Plant Protection Techniques	2	30
7. Insect Pathology	2	30
8. Integrated Management of Insect Pests	2	30
9. Processing and Management of Pesticides	2	30
10. Diseases of Horticultural Crops	2	35
11. Agricultural Environment Protection	2	36
12. Agricultural Rat Pests	2	36
13. Application of Computer in Plant Protection	2	36
14. Aquatic Insects useful in Monitoring Water Pollution	2	36
15. Crop Breeding	2	36
16. Diagnosis of Plant Diseases	2	36
17. Ecology and Forecasting of Insects	2	36
18. Entomology of Economic Crops	2	36
19. Epidemics and Forecasting of Plant Diseases	2	36
20. Identification of Agricultural Insects	2	36
21. Insect Internal Organs and Their Function	2	36
22. Integrated Management of Plant Diseases	2	36
23. Machinery for Plant Protection	2	36
24. Pathology of Economic Crops	2	36
25. Pesticide Quality Test	2	36
26. Plant Quarantine	2	36
27. Post Harvest Diseases	2	36
28. Professional English	2	36
29. Protection of Agricultural Environment	2	36
30. Research Techniques in Entomology	2	36
31. Research Techniques in Pesticide Science	2	36

32. Research Techniques in Plant Pathology	2	36
33. Resource Entomology	2	36
34. Resource Mycology	2	36
35. Storage Insects	2	36
36. Weed Control	2	36
37. Weed Science	2	36
38. Laboratory Techniques in Plant Pathology	2	45
Total	**74**	**1298**

Table 9. Centralized Practice involved in curriculum for undergraduate programme of Plant Protection since 1998 in Nanjing Agricultural University, China.*

Practice	Credits	Academic hours
Field Labour Work	1	2 weeks
Social Practice	1	2 weeks
Literature Search and Review Writing	2	
Practice teaching	2	4 weeks
Field Practice	2	4~6 weeks
Practice of Scientific Research, and Writing and Defense of Dissertation	8	13~17 weeks

* Experimental classes are not included in this Table.

THE LINKAGE OF CURRICULUM WITH PRACTICE

Practical work is very important for students to learn and to master knowledge, particularly for students of Plant Protection. As mentioned above, the current curriculum for undergraduate programme of Plant Protection in NAU emphasizes the importance of practice and the ratio of practice in the curriculum has been greatly enhanced as compared to previous curriculum. The practice consists of two parts: (1) experimental class appended to some courses and (2) centralized practical work within a certain period of time. All required specialized courses and some of the selective courses now have experimental classes. The centralized practical work include Field Practice, Practice of Scientific Research, etc. Students are trained in various kinds of skills by way of different practices. Through Field Labour Work, students learn the basic skills and procedures of crop cultivation. Through Social Practice, students learn the status of agriculture in China. Through Field Practice, students are trained to recognize and to survey the important crop pests and weeds. Through practice related to compulsory specialized courses, such as Fundamental Plant Pathology and Fundamental Entomology, students learn the basic techniques of Plant Pathology and Entomology. Through practice of Literature Searching, students learn how to search useful special subjects and related references and how to organize the information and write a good review. Through practice of Scientific Research, students learn how to start research work, how to design an experiment, and how to solve the problem(s) they encounter. During the research, they also learn how to analyze the data and how to write a dissertation for defense of the Bachelor degree and a paper for publication. It is believed that students who go through step by step all these different kinds of practices will master most of the basic skills and techniques necessary for pest management before they graduate.

OTHER AGRICULTURAL UNIVERSITIES OF SOUTHERN CHINA

There are more than 35 agricultural universities or colleges in China. Anhui Agricultural University (AAU), Huanan Agricultural University (HNAU), Jiangxi Agricultural University (JAU), Agricultural Colleges of Yangzhou University (YUAC) and Zhejiang University

Agricultural College (ZUAC) are some examples in southern China. The curricula for undergraduate programme of Pest Management (Plant Protection) in these institutions are very similar, except for minor variation in the selective courses due to geographic differences. The common basic courses and specialized courses are also almost the same among the universities (Table 10). However, only a few selective courses are offered by all these institutions, while most selective courses are offered by only some of the institutions.

Table 10. Selective courses for undergraduate programme of Plant Protection offered in agricultural universities or colleges of southern China, China.

Courses	**Agricultural universities or colleges of**				
	Yangzhou	Anhui	Jiangxi	Zhejiang	Huanan
Agricultural Ecology					
Application of Fungal Resources					
Apiculture					
Biological Control and Biopesticides					
Control of Urban Harmful Organisms					
Biological Control of Insects					
Biological Control of Plant Diseases					
Breeding for Plant Resistance to Insects					
Control of Fruit Diseases					
Control of Fruit Insects					
Control of Herbal Plant Insects					
Control of Vegetable Diseases					
Control of Vegetable Insects					
Crop Breeding					
Cultivation of Fruit Trees					
Cultivation of Vegetables					
Diagnosis of Plant Diseases					
Ecology of Insects					
Entomology of Fruits, Vegetables, Tea and Mulberry					
Epidemiology of Plant Diseases					
Forecasting of Insects					
Insect Identification Techniques					
Insects in Cities					
Insects in Storehouse					
Integrated Pest Management (IPM)					
Machinery of Agricultural Production or Plant Protection					
Rats and their Control					
Natural Enemies of Insects and their Application					
Pathogens of Insects and their Application					
Pathology of Fruits, Vegetables, Tea and Mulberry					
Pest Control in Gardens					
Pest Control of Horticultural Crops					
Pesticide Analysis					
Pesticide Chemistry					
Plant Bacteriology					
Plant Immunology					
Plant Nematode					
Plant Nutrition					
Plant Quarantine					
Plant Virology					
Post Harvest Pathology					

Principles of Plant resistance to Insects					
Processing and Application Techniques of Pesticides					
Processing for storage of Fruits					
Professional English					
Quality Examination of Pesticides					
Research Methods of Insects					
Research Methods of Pesticides					
Research Methods of Plant Protection (by Fungicides)					
Research Methods of Plant Diseases					
Residues of Pesticides and Environment Protection					
Resources of Insects					
Science of Soil and Fertilizer					
Scientific Literature Search					
Agriculture Acarology					
Sustainable Agriculture (Lecture)					
Taxonomy of Insects					
Taxonomy of Fungi					
Tests and Application Techniques of Pesticides					
Tillage					
Toxicology of Pesticides					
Toxicology of Insects					
Weeds and their Control					
Principles of Weed Killer					

* Required courses

Most agricultural universities or colleges offer similar items of practice which vary only slightly in time of duration (Table 11). The most important practice, the Practice of Scientific Research that usually lasts from 17 to 20 weeks, is conducted in the crop-growing season in most institutions. Before the research undertaking, some institutions offer special training to guide students on how to obtain the relevant information relating to the subject for study. Students are required to organise the information they get and write a review concerning the research background of the specified subject.

Table 11. Comparison among the practical work programmes in different agricultural institutions in southern China.

Practice	**Agricultural universities or colleges of**							
	Yangzhou		**Anhui**		**Zhejiang**		**Huanan**	
	A	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Field Labour Work	1	2	2	2	2	4	3	3
Social Practice	1	4	3	3	1	2	1	3
Special Training	1	2	-	-	-	-	-	-
Practice related to Specialized	3	3	3	3	3	7	5	11
Courses								
Field Practice	17	17	10	10	-	-	6	6
Practice of Scientific Research, and Writing and Defense of Dissertation			10	10	9	18	6	8
Total	**23**	**28**	**28**	**28**	**15**	**31**	**21**	**31**

A: Credits,
B: Time duration (weeks)

PROSPECTS

Agriculture is the biggest and basic industry in China. About two thirds of the population are farmers and are living in the countryside. With continuous negotiation by the Chinese government with governments of various member countries of World Trade Organization (WTO), it is expected that China will become a member of WTO before long. Once China becomes a member of WTO, it will gain a better opportunity to develop its economy while at the same time it will also encounter many challenges relating to globalization. The agricultural industry is expected to be one of the first to be affected. As a training institute in agricultural sciences, NAU, while proud of its past years of achievements, recognizes the need to look towards the future to provide China with the necessary agricultural manpower. The needed manpower must not only be qualified, but also have the needed skills and have mastered the more advanced technologies to meet the needs of China's economic development.

PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT IN CHINA AGRICULTURAL UNIVERSITY

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ABSTRACT

In 1995, the Beijing Agricultural Engineering University and Beijing Agricultural University were merged to form the national China Agricultural University (CAU). Traditionally, CAU offered a four-year Bachelor degree in Plant Protection.

The undergraduate education in Plant Protection can be divided into four stages; 1949-1965 when students were mostly enrolled in Plant Pathology or Entomology and the curriculum designed according to the demands for teaching and research, 1966-1976 when education did not play the role it should do, 1977-1999 where the focus was to develop qualified professionals for the universities/research institutions and the curricula planned on the basis to produce research-type professionals, and from 1980 onwards when there were numerous plant protection professionals with many narrow fields of specialization (particularly in the 1990s). Because such an educational system was unable to meet the needs of the society, the curriculum was further revised. Nowadays, the objectives of undergraduate education in Plant Protection include providing the students with a sound knowledge in Integrated Pest Management (IPM) and a broad-based education in a number of basic subjects. The undergraduates enroll to become specialists in Plant Protection instead of Plant Pathology or Entomology. Students may also freely take the elective courses.

Currently, undergraduate students are expected to undertake a broad-based education in Plant Protection. Perhaps in the future, even Master or Ph. D degree students will likewise need to be broad-based (studying Plant Protection) instead of continuing with the narrower fields of Plant Pathology or Entomology. By then, undergraduate students may be required to do Plant Production instead.

INTRODUCTION

China is an agricultural developing country. The development of agricultural production and agricultural modernization needs large numbers of qualified personnel. Higher education undertakes great missions in the development of the society, agriculture, and rural economy. The increasing population and decreasing land resources are the two main problems confronting the agriculture and rural economy of China. The solution to these problems depends ultimately on the advancement of science and technology and the enhancement of human resource.

Extension Service for Agricultural Techniques in villages and towns are the basic units of agricultural services. However, the number and the quality of the extension personnel cannot meet the need. Developing enterprises in villages and towns is the only way to help flourish the rural economy, increase farmers' income, and promote modernization of agriculture and development of the national economy. Whether it is developing village and town enterprises or the development of small towns, there are needs for a large pool of various professional and management personnel.

The 21st century is often referred as the biotechnology century. Agricultural universities therefore need to develop new subjects and modify existing traditional disciplines in order to meet the challenges of new technologies. The strategic reformation of agricultural economy in China should be market oriented, optimizing resources, developing sound regulatory measures and improving efficiency towards achieving high yield and high quality products. On a broad front, the higher education must be geared towards the needs of the whole rural economy and societal development rather than agricultural production only. Agricultural universities must regulate the numerous fields of narrow specializations. Students should be equipped with knowledge extending from pre-planting to post-harvest, with particular emphasis on the growing season of a crop. The traditional disciplines must be guided by the concept of market economics. Students not only need to learn techniques relating to their specific disciplines but also have a general knowledge in liberal arts, science, engineering, economics and administration. Since traditional disciplines are the strength and form the characteristics of agricultural universities, besides being the focal point from which new subjects are developed, they therefore should as far as possible be retained.

For undergraduate students, they should be exposed to new techniques and a broad-based education, covering a wide range of subject areas. This is crucial since scientific development and technologies are progressing rapidly and the social demand is for students to be knowledgeable in many diverse aspects. They are expected to be more adaptable to a wide range of disciplines than graduate students who should be more specialized in order to perform research, teaching and production activities. Some of the important broad-based educational subjects to be included are mathematics, physics, chemistry, foreign language, computer, management, humanities and an introduction to agriculture. Practical work should also form an important aspect of the training curriculum. New teaching methods are encouraged to ensure that students will continuously gain more knowledge.

The China Agricultural University (CAU) is a national university where Plant Protection is one of the offered traditional disciplines. The following is the development of Plant Pest Management Curriculum in CAU and some other universities in China.

HISTORY OF PLANT PEST MANAGEMENT CURRICULUM

An undergraduate student in Plant Protection requires four years for a Bachelor degree in China. The history of the curriculum can be traced back to 1949 when Beijing Agricultural University was founded (Beijing Agricultural University and Beijing Agricultural Engineering University were merged to become CAU in 1995). Broadely, the curriculum history of undergraduate education in plant protection can be divided into four stages.

The first stage was from 1949–1965. Students were enrolled in Plant Pathology or Entomology most of the time. The training was designed in accordance to the demands of the society, such as teaching, research, extension, and/or administration. During that time, the higher education met mostly the demands of the diverse institutions.

The second stage was from 1966–1976. It was a period that education did not fulfill its required role.

The third stage was from 1977–1999. During this period, especially in the early part, attention was given to meet the needs of universities and research institutes due to shortage of personnel. The curriculum was planned on the basis of producing research-type graduates, many of whom were trained and making great contributions to the society in the 1980s. Later in the 1990s, new and more specialized disciplines were developed. This resulted in numerous courses being offered, each having a very narrow field of specialization.

In the first half of 1990s, the course system was for specialization in Plant Pathology, Entomology, Plant Protection and Plant Quarantine. Basic courses involved a total of 2,095 hours and 88.5 credits. The basic courses included Mathematics, Physics, Chemistry, Foreign Language, Introduction to Law, Physical Education, Computer, Botany, Soil Science, Introduction to Crops, Introduction to Horticulture, Agricultural Economy and Administration, Statistics, General Genetics, Agricultural Machinery, Agricultural Meteorology, Plant Physiology, Plant Biochemistry, Agricultural Microbiology and Chemical Protection of Plants. For the specialized courses, students in Plant Pathology Specialty had 540 hours (24 credits) of obligatory courses that include General Plant Pathology, Agricultural Plant Pathology, Epidemiology and Forecast of Plant Diseases, Plant Etiology and Disease Diagnosis, Techniques in Diagnoses of Plant Diseases, General Entomology and Agricultural Entomology and 100 hours (5 credits) of elective courses that include Biological Control of Plant Diseases, Post Harvest Diseases, Plant Resistance and Techniques in Plant Pathology. The students in Entomology Specialty had 540 hours (24 credits) of obligatory courses that include General Entomology, Agricultural Entomology, Insect Taxonomy, Insect Ecology, Principles in Pest Control, General Plant Pathology and Agricultural Plant Pathology and 100 hours (5 credits) of elective courses that include Bee Keeping, Medical Insects, Urban Insects and Resources Insects. Students in Plant Protection Specialty had to have 550 hours (25 credits) of obligatory courses that include General Plant Pathology, Agricultural Plant Pathology, General Entomology, Agricultural Entomology, Forecast of Plant Diseases and Pests, Systematic Engineering in Plant Protection, Weed Control and Rodent Control and 100 hours (5 credits) of elective courses that include Disease Modeling by Computer, Plant Etiology and Disease Diagnosis, Insect Taxonomy and Introduction to Plant Quarantine and Regulation. The students in Plant Quarantine were required to have 560 hours (26 credits) of obligatory courses that include General Plant Pathology, Agricultural Plant Pathology, Quarantine of Plant Diseases, Seed Pathology, General Entomology, Agricultural Entomology, Quarantine of Pests and Introduction to Plant Quarantine and Regulation and 100 hours (5 credits) of elective courses that include Weed Control, Plant Etiology and Disease Diagnosis, Insect Taxonomy and Seminar on Plant Epidemics. All students could have 150 hours (7.5 credits) of free elective courses. A total of 32 credits of practical work were required for all students. These included general practical work at the beginning of the 3rd semester, field trials in 4^{th} -5^{th} semester, practicals within courses, practicals in General Plant Pathology and General Entomology, practicals in Agricultural Plant Pathology and Agricultural Entomology and Graduation Practicals. In total, at least 2,885 hours (157 credits) were required of students in Plant Pathology, 2,885 hours (157 credits) of students in Entomology, 2,895 hours (158 credits) of students in Plant Protection and 2,905 hours (159 credits) of students in Plant Quarantine.

In the second half of 1990s, there were more developments in the curriculum. The general and common courses for all students in Plant Protection included Mathematics, Physics, Chemistry, Foreign Language, Computer, Botany, Introduction to Crops, General Genetics, Plant Physiology, Plant Biochemistry, Agricultural Microbiology, General Plant Pathology, General Entomology, Agricultural Plant Pathology and Agricultural Entomology. These courses were required for further specialization in Plant Pathology, Entomology, Plant Protection, Plant Quarantine, Seed Processing, Rodent Control and Weed Control. The subjects Chemical Protection of Plants, Plant Etiology and Disease Diagnosis and Plant Resistance were offered for students in Plant Pathology while the subjects Chemical Protection of Plants, Insect Taxonomy, Techniques in Entomology, Insect Ecology and Forecasting and Insect Physiology for those students in Entomology. For students in Plant Protection, the following subjects were offered:

Chemical Protection of Plants, Systematic Engineering of Plant Protection, Application of Computer in Plant Protection and Forecasting of Diseases and Pests. Students of Plant Quarantine will need to take the subjects Chemical Protection of Plants, Concept and Rules of Plant Quarantine, Quarantine of Plant Diseases and Quarantine of Pests while the students of Seed Processing and Health will have to study Seed Science, Seed Treatment and Processing, Seed Materia Medica, Seed Pathology and Storehouse Pests. The subjects Chemical Protection of Plants, Weed Control, Rodent Control and Bioassay of Herbicides are required for students studying Rodent and Weed Control. Students could choose freely the elective courses. Public Labours (conducted in the first two years) and Social Practice (conducted during vocations) were also included, unlike the curriculum in the first half of 1990s. In this curriculum students should take about 2,900 hours of courses, comprising 74% that are compulsory and 26% that are electives. Theory accounted for 72% while laboratory work 28% of the required courses. There were 32.5 weeks of practical work.

Currently, the curriculum development is in the fourth stage. It has been revised in the specialized areas of Plant Protection to meet the needs of the society.

CURRICULUM REFORM

Curriculum is based on the required training plan. Therefore, the reformation of training objectives should start before that of curriculum. The objectives of undergraduate education in Plant Protection are to ensure that students have elementary knowledge and abilities in Integrated Pest Management (IPM) with a broad-based understanding in the subjects of Mathematics, Physics, Chemistry, Foreign Language, Computer, Liberal Arts, Science, Engineering, Economics and Administration. Such an integrated education would permit the development of students who can fit into related but diverse areas of activities. In total, the courses comprise 2,500 hours; the basic ones accounting about 32.8%, the professional (and basic) ones 25.4%, the professional ones 15.2% and the free electives 26.6%. Below is a summary of the reformation that have taken place.

Firstly, the required basic courses were strengthened. General Animal Science was added because pests, broadly defined, include diseases, harmful insects, weeds and rodents. In the old curriculum, there were only Botany and Agricultural Microbiology in the basic courses. These formed the bases for courses in Weeds and Diseases, respectively. Then, there was no General Animal Science to serve as the bases for Entomology and Rodents.

Secondly, key professional courses were replaced. For example, Ecological System of Cropland replaced Soil Science and Agricultural Meteorology while Agricultural Plant Pathology and Agricultural Entomology were replaced by IPM. The new course not only covered weed control and rodent control but also gave students a whole concept of IPM. Techniques in Plant Pathology and Techniques in Entomology were merged into Techniques in Plant Protection as a required course. The subject Chemical Protection of Plants was changed to Introduction to Pesticides as an elective course.

Thirdly, students could take elective courses freely not only in Plant Protection but also in any other area according to their future needs.

Fourthly, training in research capability was enhanced through practical work. Students can join the teachers' research programme one day per week to gain general knowledge in research work.

Finally, the time of graduate practical training was regulated to fit in between the 6th-7th semester (from May to September). Under the old curriculum, the practical training was in the last semester when students had to take a lot of time to find jobs. This interfered with the practical training programme and affected its quality.

Under the new curriculum, the required basic courses include Mathematics, Physics, Chemistry, Foreign Language, Computer and Philosophy. The required professional basic courses are Botany, Introduction to Crops, General Genetics, Plant Physiology, Plant Biochemistry, Agricultural Microbiology, Introduction to Agricultural Resources and Environment, Statistics, Ecological System of Cropland, General Animal Science, Agricultural Economy and Management and Writing Techniques. The required professional courses are General Plant Pathology, General Entomology, IPM and Techniques of Plant Protection. Electives of the professional courses are Insect Ecology, Insect Taxonomy, Insect Physiology, Insect Toxicology, Mites, Biological Control of Pests, Urban Insects, Medical Insects, Resource Insects, Seed Pathology, Plant Resistance, Biological Control of Plant Diseases, Post-harvest Diseases, Epidemiology of Plant Diseases, Systematic Engineering of Plant Protection, Forecasting of Plant Diseases and Pests, Application of Computer in Plant Protection, Plant Quarantine, Professional English, Weed Control, Rodent Control, Introduction to Pesticides and Advances in Plant Protection. The practicals involve Public Labour, Social Practice, Practice in General Agriculture, Practice of Botany, Field Trials, Practicals of General Plant Pathology and General Entomology, Practical IPM, Training of Research Ability and Graduation Practice.

LINKING CURRICULUM WITH PRACTICE

The basic courses are conducted during the 1st-4th terms. Students learn Public Labour (total 1 week) to gain willpower. For Social Practice (2 weeks), they can leave the campus to learn about the society. Practical work in Botany (1 week) is done in the second semester (just after the course) while that in General Agriculture (2 weeks) is conducted in experimental stations in the first two weeks of the 3rd term to expose students to agriculture.

The professional courses are done in the 5th and 6th semesters. Field trials consist of half day per week of 4th and 5th semesters, in which students can choose one crop to learn the whole process from sowing to harvesting. Practicals in General Plant Pathology and General Entomology last 2.5 weeks in the end of the 5th term (just after the courses). Training to improve research capability consists of half-day per week during the 5th term.

Students can take elective courses in the 6th, 7th, and 8th semesters. The practical for IPM is conducted during vocation between the 6th and 7th semesters (just after the course). Students spend 5 weeks visiting farms and greenhouses to learn techniques in plant protection. The Graduation Practice is from May to September in the summer vocation between the 6th and 7th semesters and also overflows partly into the 6th and 7th semesters. Both the practical for IPM and the Graduation Practice overlap with each other.

EXAMPLES IN OTHER AGRICULTURAL UNIVERSITIES OF CHINA

1. Shenyang Agricultural University

Shenyang is located in Liaoning Province, northeast of China. It is a national university under the charge of the Ministry of Agriculture. The curriculum for undergraduate students is designed on the basis of Plant Protection Specialty.

The non-elective courses are divided into common courses, basic courses, professional basic courses, and professional courses. Common courses constitute 720 hours, including Philosophy, Political Economics, Law Basis, Thought and Self-Cultivation, Situation and Policy, Foreign Language, Sports and Computer. The basic courses have a total of 540 hours, including Mathematics, Chemistry, Basic Biochemistry and Botany. Professional basic courses include Plant Physiology, Statistics, General Entomology, General Plant Pathology and Genetic Breeding of Plants, all of which add up to 410 hours. Agricultural Entomology, Agricultural Plant Pathology and Chemical Protection of Plants make up the professional courses that add up to 240 hours. In total, the required courses need 1,910 hours.

Elective courses are divided into ‘direction elective courses’ and those that are ‘free elective courses’. In the case of students pursuing Plant Pathology, the ‘direction elective courses’ include Epidemiology and Forecast of Plant Diseases, Plant Immunology, Methods in Phytopathological Research and Practical Techniques in Plant Pathology. For those doing Entomology, the courses are Pest Ecology and Forecast, Biological Control of Pests, Methods in Entomological Research and Field Techniques of Pests. For students involved with pesticides, the courses are Weed Science, Pesticide Toxicology, Methods in Pesticide Research and Operation Techniques of Pesticides. The ‘free elective courses’ include Agricultural Meteorology, Crop Cultivation, Instrument Analyses, Computer Application, Ecological Basis, Vegetable Cultivation, Cultivation of Fruit Trees, Plant Quarantine, Soil Fertilizers, Agricultural Machinery, Literature Searching, Plant Virology, Plant Bacteriology, Plant Nematology, Fungal Taxonomy, Biological Control of Plant Diseases, Diseases of Ornamental Plants, Molecular Plant Pathology, Professional English in Plant Pathology, Larvae Taxonomy, Agricultural Mites, Insect Pathology, Insect Physiology, Urban Insects, Resource Insects, Insect Taxonomy, Professional English in Entomology, Rodent and Control on Farmland, Pesticide Assays, Biological Pesticides, Regulators for Plant Growth, Tests and Management of Pesticide Resistance and Professional English in Pesticides. Students must choose one stream (e.g. Plant Pathology or others) and take at least 14 credits of ‘direction elective courses’ and 10 credits of ‘freely elective ones’.

2. Northwest Agricultural University

This university is located at Yangling town, Shaanxin Province, northwest of China, and is also a national university under the Ministry of Agriculture. The curriculum for undergraduate students is designed on the basis of Plant Protection Specialty.

The required courses include common courses, basic courses, professional basic courses, and professional courses, adding up to a total of 2,275 hours. The common courses cover Philosophy, Political Economics, Basic Law, Thought and Self-Cultivation, Foreign Language, Computer and Sports. The basic courses include Mathematics, Physics, Chemistry, Botany, Plant Biochemistry, Plant Physiology, Agricultural Meteorology, Microbiology and Agricultural Environment. Professional basic courses are composed of General Plant Pathology, General Entomology, Genetics, Crop Science, Insect Ecology and Forecast, Ecology and Forecast of Plant Pathology and Statistics. Agricultural Entomology, Agricultural Plant Pathology and Chemical Protection of Plants make up the professional courses.

Elective courses are divided into ‘professional basis’ and ‘special directions’. Students should take at least 12 credits from Professional English, Introduction to Horticulture, Soil Fertilizers, Weed Science, Literature Searching, Agricultural Economics, Resource Insects and Insect Physiology. The students also need to choose one or more ‘special direction’ courses with at least 5.5 credits. The elective courses for Plant Pathology specialization include Plant

Bacteriology, Plant Virology and Plant Immunology; those for Entomology specialization are Invertebrates, Rodents and Biological Control of Insects; those for Pesticide specialization are Pesticide Bioassays, Pesticide Toxicology and Pesticide Analysis; and those for Plant Quarantine specialization are Insect Taxonomy, Taxonomy of Plant Pathogens and Plant Quarantine.

PROSPECTS

Undergraduate education of plant protection in China is confronted with the challenges from new technologies, the reformation of centrally-planned economic system to that of market-oriented, the extent of plant protection requirement from preplanting to post-harvest, and the need for sustainable agriculture development. With greater demands for better services and produce by the society, the need for quality personnel to meet these demands is constantly increasing. Students are faced with two options after graduation; one is to find jobs directly and another is to continue their studies for Master Degree, or subsequently Ph. D Degree. Those of the first option have diverse choices of demands from different kinds of institutions, such as teaching, research, production, extension, business, administration, etc. Those of the second option will need to study hard in some specialized aspects. Therefore, the undergraduate education is a big platform for specialty development. It must provide the environment for developing a broad range of specialists with strong foundation, of good quality and capability, and possessing innovative minds and spirit which can blaze new trails.

Currently, the undergraduate students in Plant Protection are enrolled to specialize in Plant Protection while the graduate students (Masters and Doctorates) are to specialize in Plant Pathology or Entomology. Undergraduate students are expected to have general and broad training while graduate students to become specialists. In the future, perhaps the quality of undergraduate and graduate students will need to be improved further. Graduate students may need to have a general and broad training instead, in which case Master Degree students (or even Doctorates) will be enrolled in Plant Protection instead of Plant Pathology or Entomology. The undergraduate students may then need to register for Plant Production. In general, undergraduate students, Master and Doctorate students make up a pyramid, with the width of the base representing the level of knowledge and capability. The wider the base, the better the knowledge and capability. The new width is expected to produce a new and greater height, and the new height needs an even wider width, and so on and so forth.

PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT IN INDIA

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ABSTRACT

Indian agriculture has made significant progress in increasing crop production. Beginning with the first agricultural university at Pant Nagar in 1960, India now has one of the largest networking of agricultural education system today. It provides education to about 10,000 students in 11 undergraduate programmes of agriculture and allied sciences and about 6,000 students in post-graduate programmes in more than 60 disciplines. Human resource development is regarded as the most important factor to quickly popularize the latest technological development in plant protection among the farmers.

The Bachelor degree holders constitute the bulk of recruits for public and private sectors in agriculture. From time to time, the Dean's Committees of the Indian Council of Agricultural Research have recommended model curriculum to unify the curricula of agricultural universities.

In the past, postgraduate education in Entomology and Plant Pathology has received little attention. But Plant Protection has become important recently because of global concern about environmental and health effects of pesticides, related issues of international trade and the need for Integrated Pest Management (IPM) approach. Reorientation of formal education and extension methods becomes crucial as IPM assumes more importance. IPM courses for both the undergraduate and post-graduate levels have also been proposed.

In general, many graduates now in extension functionaries lack practical experience. Training to upgrade their professional competence is needed. Presently, the National Plant Protection Training Institute at Hyderabad and the Directorate of Plant Protection are generating trained manpower in IPM of rice, cotton, vegetables, and some oilseed and pulse crops. These involve season-long Training-of-Trainers programmes and other long and short training programmes. The curriculum, updated regularly, is aimed at developing IPM skills, and is augmented with panel discussions, special topics and group dynamics.

Since the Government of India and the State Governments are providing increasing support in IPM among farmers, it is envisaged that there will be a greater need for the introduction of IPM courses in the curricula of universities/institutes.

INTRODUCTION

Agriculture is the backbone of the Indian economy. The most important goal in agriculture is to achieve higher productivity and production to meet the ever-increasing demand of food commodities/products. In order to achieve this, a number of scientific disciplines and diverse kinds of resources have to be deployed in a well-planned and systematic manner. The primary producers also must be made aware of the great potentials through the application of science in agriculture. Plant protection technology occupies an important position in agricultural crop production. Most often, losses due to pests are the major limiting factor for sustaining the increase in crop productivity and production. On average, the avoidable crop losses caused by pests, such as insects, diseases, weeds and others in India, have been estimated to range from 10% to 30% of the total production. To keep pace with the demand for food commodities, adoption of appropriate strategies that include effective, economical, safe and environmentally sound plant protection technology in sustainable agriculture, is a critical requirement. Agricultural education caters to the needs of the country's manpower in utilizing research and extension appropriately for the country. Curriculum plays an important role in imparting knowledge and skill required for human resource development in any discipline. Periodic revision of syllabi by all institutes of learning is an essential component of curriculum development to produce qualified and competent manpower to handle emerging situations in a rapidly changing agricultural scenario. The curriculum for plant pest management in agricultural universities and allied institutes is thus an integral part of agricultural education. The current status and future needs of plant pest management curriculum in agricultural education in India is presented below.

THE GENESIS OF AGRICULTURAL EDUCATION IN INDIA

There is historical evidence to show that agricultural education existed in India during the medieval period. Sporadic attempts were made in early times to have schools for training in agriculture. However, organized instruction in agriculture was first introduced at the beginning of the twentieth century when six agricultural colleges offering diploma courses were established at Kanpur, Lyalpur (now in Pakistan), Coimbatore and Nagpur in the year 1906, in Pune in 1907 and in Sabour in 1908. Fullfledged departments/faculties of agriculture were set up by some of the universities such as at Calcutta, Benaras and Viswa Bharati before the agricultural universities came into existence. The University Education Commission (1948–49) under the Chairmanship of the eminent educationist Dr. S.Radhakrishnan recommended the setting up of ‘Rural Universities’ to cater for the needs of Agriculture in India. Subsequently, two Joint Indo-American Study Teams headed by K.R.Damale (1955) and M.S.Randhawa (1960) recommended the establishment of agricultural universities on the pattern of the Land Grant Colleges of USA. Accordingly, the first such State Agricultural University (SAU) in the country was set up at Pant Nagar in Uttar Pradesh in 1960. Thereafter, more agricultural universities were established in various States in quick succession. Presently, there exists 28 State Agricultural Universities (SAU) in the country, one Central Agricultural University and four Institutes under the Indian Council of Agricultural Research (ICAR). The latter four Institutes are of the status equivalent to universities. ICAR is also assisting the development of agricultural faculties of three Central Universities, *viz*: Banaras Hindu University, Alligarh Muslim University and Viswa Bharati. Apart from these universities and ICAR institutions, 35 agricultural colleges are affiliated to traditional universities. In addition, there are many institutes/training centres at Central and State Government levels for in-service training of their personnel. Thus, India's national agricultural education and research system is one of the largest in the world, providing educational facilities in 11 degree programmes in agricultural and allied subjects, and post-graduate programmes in more than 60 disciplines with an annual intake of about 10,000 undergraduate and 6,000 postgraduate students.

PLANT PEST MANAGEMENT CURRICULUM: HISTORY AND REFORM

Undergraduate Education

The Bachelor Degree holders constitute the bulk of recruits for the public sector programmes of development in agriculture. Therefore, high quality undergraduate education is very essential and critical. It is an accepted national policy that entrance to the universities has to be after 12 years of pre-university education known as the 10+2 system.

The first major exercise for improvement of curriculum and courses of agricultural education was undertaken in the late 50s by the erstwhile ICAR that formulated model curriculum for the undergraduate programme in agriculture. The First Committee of Deans from agricultural universities in 1965 examined the status of undergraduate curriculum in agriculture and provided some broad guidelines for the development of curriculum so that it could be a useful programme. Most of the universities have tried to follow the guidelines framed by ICAR. So, a fairly uniform pattern has emerged. The Second Dean's Committee in 1981 recommended a model curriculum for undergraduate education in agriculture. This provided the basic guidelines for developing curricula by universities. The Committee recommended a 4-year, 8-semester undergraduate degree programme after the 10+2 years of pre-university education. The Committee also recommended a crop-production-oriented programme with practical field training and rural work activities to enable graduates to understand the agricultural and socio-economic complexities of rural farmers. To provide additional knowledge and training in selected areas of agricultural development, the Committee suggested that the curriculum should provide at the final stage of the degree programme a wide range of electives that are employment-oriented instead of specializations in academic disciplines. Furthermore, there should be 149 semester credit hours for B.Sc. (Agriculture) programme that included 8 credits in Entomology, 7 credits in Plant Pathology, 2 credits each in Nematology and Weed Control with a provision of 12 credits for Plant Protection Electives (optional). These recommendations have been accepted and implemented by majority of the universities. However, no university offered the Integrated Pest Management (IPM) course or Bachelor Degree programme in Plant Protection. More recently, the Third Dean's Committee (1995) recommended 160 credits for a 4-year undergraduate degree programme with a weightage of 12 (7+5) credits for Entomology, 10 (5+5) for Plant Pathology and 2 (1+1) for Weed Management and Nematology each. These also have two courses of 2 credits each, one on IPM and the other on Plant Disease Management. Furthermore, there is a 2 (1+1) credit load for Environmental Science and Agroecology. Besides, an additional 25% workload in Rural Agricultural Work Experience Programme (RAWEP - 21 credits) has been earmarked for Plant Protection. Thus, the total weightage for Plant Protection courses as recommended by this Dean's Committee is about 32 credits out of a total of 160 credits. The credits allocated for these Plant Protection courses excluding RAWEP in certain State Agricultural Universities are presented in Table 1.

Table 1. Plant protection curriculum in undergraduate programme at agricultural universities in India (Course title with numbers indicating the credit hours)

Mahatma Phule Krishi Vidyapeeth, Rahuri

1. Introductory Entomology 1 + 1
2. Insect Development Classification & Applied Entomology 2 + 1
3. Economic Entomology - I 1 + 1
4. Economic Entomology - II 1 + 1
5. Introductory Plant Pathology 1 + 1

6. Diagnostic Techniques (Path) 0 + 1
7. Diseases of Crop Plants - I 1 + 1
8. Diseases of Crop Plants - II 1 + 1
9. Agricultural Nematology 0 + 1

Electives (optional)

10. Ecology and Environment 1 + 1
11. Repair & Maintenance of Plant Protection
12. Plant Protection 1 + 1

Equipment 1 + 1

Orissa University of Agriculture & Technology, Bhubaneshwar

1. Introductory Entomology 3
2. Principles of Pest Control 2
3. Economic Entomology 3
4. Introductory Mycology 2
5. Principles of Plant Pathology 2
6. Plant Diseases & their Control 3
7. Plant Nematology 2
8. Weeds & Weed Control 2

Electives (optional)

9. Storage Entomology & Rodent Control 2
10. Economic Nematology 2

Acharya N.G.Ranga Agricultural University, Hyderabad

1. Introduction to Entomology 2 + 1
2. Insect Taxonomy, Ecology & IPM 2 + 1
3. Crop Pests & their Management 3 + 1
4. Field Diagnosis in Agriculture (Entomology) 0 + 1
5. Sericulture, Apiculture & Lacculture 1 + 1
6. Introduction to Plant Pathogens 2 + 1
7. Principles of Plant Pathology 2 + 0
8. Diseases of Field & Horticultural Crops 3 + 1
9. Plant Disease Management 1 + 1
10. Weed Management 1 + 1
11. Agricultural Chemicals 1 + 1
12. Environmental Science & Agroecology 2 + 1

Tamil Nadu Agricultural University, Coimbatore

1. Fundamentals of Entomology 2 + 1
2. Economic Entomology 2 + 1
3. Principles & Methods of Pest Management 2 + 1
4. Pests of Field Crops & their Management 1 + 1
5. Pests of Horticultural Crops & their Management 1* 1
6. Fundamentals of Plant Pathology 2 + 1

7. Principles of Plant Disease Management 1 + 1
8. Diseases of Field Crops - I 1 + 1
9. Diseases of Field Crops - II 1 + 1
10. Diseases of Horticultural Crops 1 + 1
11. Plant nematology 1 + 1
12. Weed Management 1 + 1
13. Agricultural Chemicals & Soil Pollutants 2 + 1

G. B. Pant University of Agriculture and Technology, Pant Nagar

1. Introductory Entomology 2 + 1
2. Economic Entomology 2 + 1
3. Insect Pests & their Management 2 + 1
4. Introductory Plant Pathology 2 + 1
5. Crop Diseases & their Management 2 + 1
6. Mushroom Cultivation 0 + 1
7. Weed Management 1 + 1
8. Environmental Science & Agro-ecology 2 + 1

Chowdhury Charan Singh University, Meerut also awards B.Sc. (Agriculture) degree and follows the annual system of ‘marks’ and not the ‘grade point’ or the Course-Cum-Credit System. In this 4-year undergraduate programme, three out of 24 courses are plant protection related, having a weightage of 225 marks out of 1950 marks, *viz*:

1. Plant Pathology & Microbiology 50 + 25
2. Agricultural Entomology 50 + 25
3. Plant Protection 50 + 25

In general, a similar curriculum is also followed in some of the other universities. The total credits for a 4-year B.Sc. (Agriculture) programme may vary from 145 to 181 (with Theory class of 1 hour and 2–3 hours practical in most SAUs). Total credits alloted to Plant Protection courses (Entomology, Plant Pathology, Nematology and Weed Science) ranged from 17–31 credits with 8–13 credits for Entomology and 8–12 credits for Plant Pathology. In Table 1, Nematology is included in Plant Pathology wherever it is offered separately. Though Weed Science is considered a part of Pest Management, for obvious reasons it is a component of Agronomy and dealt with accordingly. However, in Table 1, it is included in the total Plant Protection credits wherever it is offered as a separate course. In addition, most of the universities are offering courses in Agricultural Chemicals/Pollutants/Environmental Science and Agroecology ranging from 2 to 5 credits which are Plant Protection related but included in Soil Science and Environmental Science Faculties. The Third Dean's Committee also felt that the exposure of students to post-harvest and storage technology of agricultural produce is lacking and that it is necessary for students to be trained in this aspect, and therefore, recommended a 2-credit course on Post-Harvest Technology. At present, the pest management in post-harvest stage is covered in Entomology under Crop Pest Management and partly in the Post-Harvest Technology course for undergraduates. In most of the universities, there is no separate course to cover this topic. However, Storage Entomology and Rodent Control, a 2-credit course is offered as optional in some universities.

Post-graduate Education

The post-graduate education in universities did not receive much attention in the past. Presently, however, the agricultural university system in India provides for postgraduate education in more than 60 disciplines in agriculture and the allied sciences. There is a need to look into the curriculum and recommend well-designed courses that can provide advanced and in-depth knowledge to the students to face the many emerging challenges. The universities presently offer post-graduate degrees in Entomology, Plant Pathology (including Nematology) and Agronomy with specialisation in Weed Management. But, only few universities offer Master of Science degree in Plant Protection as a subject, *viz:* Viswa Bharati, Tamil Nadu Agricultural University and Aligarh Muslim University. Table 2 gives an example of the existing curriculum for post-graduate level education in the faculty of Entomology at the ANG Ranga Agricultural University, Hyderabad. The total credits requirement for a Master degree programme is 56 credits which includes a minimum of 18 credits each for the major and minor subjects and 20 credits for research. For Doctoral programme, the total requirement is 75 credits which include 22 credits for the major subjects, 8 credits for minor subjects and 45 credits for research.

Table 2. Curriculum for post graduate programme in the Faculty of Entomology at Ranga Agricultural University, Hyderabad, India.
(Course title with numbers indicating the credit hours)

Ent.	630	Insect Morphology 4 (3 + 1)
Ent.	631	Insect Ecology3 (2 + 1)
Ent.	632	Insect Physiology 3 (2 + 1)
Ent.	633	Insect Toxicology 3 (2 + 1)
Ent.	634	Insect Taxonomy 3 (1 + 2)
Ent.	635	Biological control of crop pests & weeds 3 (2* 1)
Ent.	636	Insect Resistance in crop plants 2 (2 + 0)
Ent.	637	Insect Transmission of plant Diseases 3 (2 + 1)
Ent.	638	Pests of Field crops 3 (2 + 1)
Ent.	639	Pests of Horticultural crops 3 (2 + 1)
Ent.	730	Pests of Stored produce 3 (2 + 1)
Ent.	731	Sericulture 2 (1 + 1)
Ent.	732	Introductory Nematology 3 (2 + 1)
Ent.	733	Rodentology 3 (2 + 1)
Ent.	734	Plant Acarology 3 (2 + 1)
Ent.	735	Insect Pest Management 2 (2 + 0)
Ent.	736	Techniques in Entomology 3 (1 + 2)
Ent.	738	Advanced Insect Taxonomy 3 (2 + 1)
Ent.	739	Advanced Insect Ecology 3 (2 + 1)
Ent.	830	Biological control of crop pests through 3 (2* 1)
Entomophagous insects		
Ent.	831	Biological control of crop pests through pathogens 3 (2 + 1)
Ent.	832	Biotechnology in Pest Management 2 (1 + 1)
Ent.	835	Insect Neurobiology & Endocrinology 3 (2 + 1)
Ent.	836	Insect Dietetics & Meabolism3 (2 + 1)
Ent.	837	Insect Behaviour 2 (2 + 0)
Ent.	930	Toxicity & Metabolism of insecticides 3 (2 + 1)
Ent.	931	Insecticide Formulations 2 (1 + 1)
Ent.	932	Insecticide Residue Analysis 3 (1 + 2)
Ent.	933	Insecticides & Environment 3 (2 + 1)

Ent.	936	Biology & Ecology of nematodes 3 (2 + 1)
Ent.	937	Nematode control 3 (2 = 1)
Ent.	935	Techniques in Plant Nematology 3 (1 + 2)
Ent.	938	Plant Nematode Relationships & Disease complexes 3 (2 + 1)
Ent.	710	M.Sc. Seminar1 (1 + 0)
Ent.	810	Ph.D. Seminar1 (1 + 0)
Ent.	720	M.Sc. Research 20
Ent.	820	Ph.D. Research 45
Core Courses for M.Sc. (Ag.)		
Ent.	630	Insect Morphology 4 (3 + 1)
Ent.	631	Insect Ecology3 (2 + 1)
Ent.	632	Insect Physiology 3 (2 + 1)
Ent.	633	Insect Toxicology 3 (2 + 1)
Ent.	634	Insect Taxonomy 3 (1 + 2)
Ent.	600	Statistical Methods 3 (2 + 1)
BICM.	602	Plant Biochemistry 3 (3 + 0)
Ent.	710	M.Sc. Seminar1 (1 + 0)

In-Service Education/Training

The plant protection extension functionaries in the officer cadre are generally agricultural graduates who join the service after their initial education at the college level. The Committee on Agricultural Universities has highlighted the weakness in terms of practical training in the curricula of undergraduate degree programmes. Consequently, the graduates are unable to handle with confidence many practical problems encountered in the field and cannot serve as professional agriculturists. There is a need for reinforcing the professional competence of extension functionaries through imparting knowledge, diagnostic capability, practical and problem solving skills, attitudinal change leading to confidence building and capacity building. Only a few extension workers are able to transform a technical recommendation into instructions that farmers can follow. It has been recognized that training can help develop this capability in extension personnel. Inservice training, therefore, has assumed considerable importance in this context where extension officers are expected to provide more specific and specialized guidance to the grassroot level extension functionaries who handle various production programmes.

Training in Pest Management of Field Crops

In India, the agricultural programmes expanded considerably in the sixties and so also are the plant protection programmes. Moreover, there was growth in the number of extension functionaries in the different States. There was greater need for plant protection interventions to reduce crop losses caused by pests. Lack of adequate trained manpower in plant protection in the States was one of the major constraints in organizing appropriate control measures against crop pests. According to the recommendations of the Planning Commission of India in 1957, there should be at least one plant protection specialist at the ‘block level’. Thus, a need was felt that the national training strategy should build an efficient cadre of plant protection personnel. Recognizing this need, the Central (now National) Plant Protection Training Institute (NPPTI) was established at Hyderabad in 1966 as a training wing of the Directorate of Plant Protection, Quarantine & Storage under the Ministry of Agriculture, Govt. of India. The Institute has the main objective of human resource development in plant protection. The NPPTI has been entrusted with the responsibility of training master trainers and subject-matter specialists in the State Departments of Agriculture on different aspects of plant protection technology. Over the years, this premier national institute for training in plant protection technology has been strengthened to become a Centre of Excellence. It is now acknowledged as a Regional Training Centre for Plant Protection by the Food and Agriculture Organization of the United Nations. The NPPTI organizes long term and short term training programmes. Currently, the important training programmes are:

1. Post Graduate Diploma Course in Plant Protection.
2. Training in Pesticide Formulation Analysis.
3. Training in Pesticide Residue Analysis.

The Post-Graduate Diploma Course is of 10-month duration. It is designed for inservice personnel with B.Sc. degree in agriculture and who are working in various State Departments of Agriculture. The course is also open to those unemployed agricultural graduates who wish to take up plant protection as their career. In pursuance of the recommendations of the Project Coordination Committee for UNDP Project for strengthening of NPPTI, the Ministry of Agriculture, Govt. of India, set up an Academic Committee in 1976. This Committee was to draw up the curriculum and dealt with related issues for the Post-Graduate Diploma Course in Plant Protection. The course contents/syllabi have been constantly revised by incorporating the latest developments in plant protection technology. Table 3 provides the curriculum for the Diploma Course.

Table 3. Curriculum of the post-graduate diploma course in plant protection in India. (Course title with numbers indicating the credit hours)

1. Principles of Pest Management 2 + 1
2. Plant Protection I 2 + 1 (Pest management in cereals and millets)
3. Plant Protection II 2 + 1 (Pest management in vegetables and fruits)
4. Plant Protection III 2 + 1 (Pest management in pulses, oilseeds and commercial crops)
5. Special topics in Plant Protection 2 + 1
6. Pesticide Chemistry 2 + 1
7. Plant Protection Equipment 2 + 1
8. Plant Protection Extension 1 + 1
9. Seminar * 0 + 1
10. Field Service Training 0 + 2
11. Plant Protection Research * 0 + 3
12. Institutional Visit + Study Tour * 0 + 1

Total Credits 30

* Participation in both semesters

The training course consists of 30 credit hours to be covered in two semesters, each consisting of 19 weeks with a break of 4 weeks for study tour and individual projects. Crop-based IPM approach is emphasized. Field Service Training is one of the important aspects of this course in which participatory action research and agroecosystem analysis in different crops in the farmers' fields are carried out. The trainees have interaction with farmers about their field problems and how to solve them. The faculty members guide the trainees to ensure that the officer-trainees would gain full confidence about communication with farmers. They are also fully backed with the required technical competence in knowledge and skills. The Pesticide Formulation Analysis Course is 3 months long and is organized for those who are/will be manning the Pesticide Testing Laboratories that are concerned with quality control of pesticides under the Insecticides Act. The curriculum covers analysis of pesticide formulations that are commonly available and uses the latest sophisticated analytical techniques that are reviewed and updated regularly. This curriculum is given in Table 4. To undergo the course, trainees must have at least B.Sc. (Agriculture) degree. The course is essentially laboratory-oriented with the training largely hands-on.

Table 4. Curriculum of pesticide formulation analysis course. (Duration is three months)

1. Theory

- Introduction to basic principles of chemical analysis by volumetric, chromatographic and spectroscopic techniques.
- Introduction to structural representation of organic molecules with special reference to pesticides.
- Principles, reactions, calculations, procedures, precautions involved in analysis of various pesticides and their formulations.
- Pesticide formulations and their compositions.
- Toxicity, symptoms of poisoning, first aid and antidotes for pesticide poisoning.
- Insecticides Act-1968 and rules framed thereunder and other legal aspects.
- Quality control of pesticides.

2. Practical

Officer trainees have to perform analysis of the following pesticides.

Insecticides:	endosulfan, carbaryl, carbofuran, oxydemton-methyl, phosphamidon, dichlorovos, monocrotophos, methyl parathion, dimethoate, quinalphos, phosalone, synthetic pyrethroids, neem based pesticides, etc.
Fungicides:	copper oxychloride, sulphur, dithiocarbamates, captan, carbendazim, etc.
Herbicides:	2, 4-D, atrazine, butachlor, glyphosate, etc.
Rodenticides:	zinc phosphide, aluminium phosphide, bromadiolone, etc.
Acaricides:	dicofol.

3. Seminar

Officer trainees have to choose a topic related to the training course and give a talk for about 15 minutes. Officer-trainees are guided by the staff when they prepare for the seminar.

4. Study tour

Officer-trainees have to undertake educational study tour of about 10 days duration.

5. Record

Officer-trainees have to maintain the practical record book which has to be submitted periodically for correction.

6. Examination

Theory and practical examinations are conducted at the end of the course and the over-all performance of the trainees is evaluated.

The Pesticide Residue Analysis Course is a post-graduate course of 3 months duration. The participants must have at least B.Sc. (Agriculture). This course includes a detailed theoretical background to pesticide residue analysis in food commodities and related sampling methods in the environment. Laboratory exercises using highly sensitive analytical techniques form an important part and trainees are given extensive hands-on training. The curriculum is periodically updated and revised to ensure that it meets with the current requirements.

PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT IN INDIA

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ABSTRACT

Entomology and Plant Pathology were the main subjects in early plant protection science. Today, instruction in Plant Protection is offered by more than 30 State Agriculture Universities, one Central Agriculture University and 20 general universities (through 48 colleges). Agricultural education has passed through different phases, starting from the conventional British University System to trimester followed by the semester system.

The Indian Council of Agricultural Research (ICAR) has been instrumental in curricula changes for different undergraduate and post-graduate programmes in India, with detailed guidelines developed by the Dean's Committee. The aim is to produce agricultural graduates with a strong pest management capability so as to assure greater sustainability in agricultural production and to protect the environment.

Graduates may take a career in teaching, research, extension, consultancy or agribusiness in plant protection. With this in mind, ICAR has recommended the B.Sc. (Ag.) and B.Sc. (Hort.) degrees to include the important feature of Rural Agricultural Work Experience. The latter permits students to do practical training in farmers' fields to gain real life experience in pest management.

Regular in-service training for extension personnel and researchers is considered crucial. Currently, ICAR crop research institutes provide such training in commodity-based IPM while ICAR National Centre for IPM provides in-service orientation programme to university teachers and extension personnel. For the latter, the National Plant Protection Training Institute plays a key role in providing the needed inservice training within the country.

For post-graduate courses, many additional aspects relevant to plant protection will need to be included, such as, latest surveillance/forecasting techniques, quarantine laws, pest risks analysis, protected horticulture, mass production of bioagents, bio-informatics, and others.

INTRODUCTION

The green revolution in India has led to a quantum jump in agricultural production, thereby placing the country in a comfortable position as regard to domestic food demand. However, the expected population of 1,100 million by 2050 is bound to create pressure on the available land. This will lead to a reduction in per capita availability of land, which at the present rate will decline to 0.13 ha by 2050 from the present level of 0.22 ha. With 960 million people, and nearly 18 million people added annually, India will be required to produce 240 million tonnes of food grains by the year 2006. Even with the fall in the population growth from the current 1.8 per cent to 1.4 per cent by 2011, India's population will continue to grow by an additional 16 million people each year. Just to nurture this population alone, Indian farmers will have to produce an additional 3.2 million tonnes for each year (Singh, 1998).

Pests, which include any species, strains or biotypes of plant, animal or pathogenic agents injurious to plants or plant products are major production constraints. On average, they cause 15–20% losses in crop yield. An estimated 75,000 species of insect pests (and much more than this for diseases) affect agricultural corps worldwide. The number of diseases is on the increase as a result of co-evolution in pathogens in response to changing hosts and micro-climate. Even with reduction of just half of these losses, India would annually harvest an additional 15 to 20 million tonnes of food grains (Singh, 1998). Krishnamurthy Rao and Murthy (1983) estimated these annual losses in India at Rs. 60,000 million which later increased to Rs. 200,000 million (Jayaraj, 1993). Recent estimates of losses stand at Rs. 290,000 million (Dhaliwal and Arora, 1996).

Intensive agricultural practices have relied heavily on chemical inputs that on occasions have proved to be eco-destabilizing. Pesticide sprays have served as insurance to a bigger harvest. As a result, the pesticide use has increased from 434 tonnes (technical grade) in 1954 to more than 80,000 tonnes in recent years. Surprisingly, more than 36% of this quantity is used in Andhra Pradesh alone and nearly 53% on cotton crop although the latter occupies only 5% of cropped area in the country. The pesticide industry in the country is presently valued at between Rs. 22,000–25,000 million worth per annum.

The enormous amount of losses due to pests has always attracted the attention of scientists in India. In the earlier years, the emphasis was more on controlling the pests rather than their management. The initial attempts to develop the required human resource for research and extension activities focussed on two disciplines, namely, Entomology and Plant Pathology. Weed control was treated just as one of the operations in crop production by agronomists while nematode problems were grossly neglected.

HISTORY OF PLANT PEST MANAGEMENT CURRICULUM

At present the instructional programme in various disciplines of plant pest management is offered at 30 State Agricultural Universities (SAUs), one Central Agricultural University and one deemed University of the Indian Agriculture Research Institute (IARI). Besides, there are 20 general universities with several affiliated colleges/departments offering undergraduate and post-graduate programmes. There are 48 such colleges/departments in India of which 31 offer post-graduate instructions. Organized instruction in plant protection was introduced in the beginning of the 20th Century when five agricultural colleges were established in 1907. After passing through various phases of development the SAU system came into existence.

Historically, plant protection education was the responsibility of the agricultural colleges and other institutes affiliated to the general universities. Undergraduate students were offered subjects like Zoology in the first year, Agricultural Entomology in fourth year, General Bacteriology in the second year and Plant Pathology in the fourth year for a four-year degree programme. However, since 1960 the course curriculum was changed and the subjects included Zoology in pre-university, Internal Anatomy in B.Sc. Part 1 and Economic Entomology in B.Sc. Part III (or final year) of the degree programme.

For M.Sc. (Agri.) degree programme, students had to write three papers for Entomology, *viz:* (i) Morphology, Physiology and Taxonomy, (ii) Economic Entomology, and (iii) Applied Entomology. For Plant Pathology, the papers were (i) Principles of Plant Pathology, (ii) Diseases of Crop Plants, and (iii) Bacteriology, Virology and Nematology. These were patterned after the British teaching model.

After the establishment of Agricultural Universities, most of the colleges adopted the trimester system of education. The general distribution of courses in Entomology and Plant Pathology for B.Sc. (Ag.) comprises 18 credit hours allotted to Entomology and 13 credit hours to Plant Pathology out of a total of 208 credit hours. In addition, students had to take some elective courses. Unfortunately, this system did not work well in the colleges of SAUs. There were wide variations in the duration, credit load, number of subjects covered and pattern of education imparted. While the number of courses giving instructions in pest management was fairly constant (varying from four to five) in Entomology and Plant Pathology, the pattern of farm training, extent of the topics covered, sequencing of courses, and others, showed very wide variations among the different Institutions offering the courses. The examination system and evaluation also varied. Therefore, it was subsequently decided to change to a more uniform system of education.

The system of education, evaluation and grading in various Agricultural Universities reveal that all of them are now following the semester system except for IARI which continues with the trimester system. Distribution of courses in Entomology and Plant Pathology for B.Sc. (Agri) under the semester system included 5 courses in Entomology with 8 credits and 3 courses with 7 credits in Plant Pathology. The graduation programme has a total of 117 credits which also include the electives and other core courses. Students also have to carry out actual plant protection operations in the field under the WEX (Work Experience) course. The post-graduate students have a choice to take different courses depending upon the nature of the research problem they undertake. In general, very few students opt for the course in Insect Taxonomy or select research problems relating to Systematics.

THE REFORM OF CURRICULUM

Education is a dynamic process as it should be relevant to the changing needs of the society. Course curriculum is the first and very important component of education. It is the basic requirement to go through and be understood well by a student to gain knowledge and develop skills to perform a specific function. Therefore, to keep education relevant, the course curriculum should be periodically reviewed and modified to suit the ever-changing requirements of the society.

The Indian Council of Agricultural Research (ICAR) has been instrumental in effecting curricula changes of different undergraduate and post-graduate programmes in the country since 1950s. The first major exercise was made in the late 50s by the then Indian Council of Agricultural Education that formulated the model curriculum for B.Sc. (Agri.) programme. After the establishment of SAUs, ICAR has made periodic exercises to revise the curriculum and course outlines in agricultural education. The first Dean's Committee appointed by the Council submitted its report in 1965, which provided detailed guidelines for undergraduate and post-graduate education. The Agricultural Universities Review Committee headed by Dr. M.S. Randhawa (1977) suggested the constitution of the Second Dean's Committee. This committee headed by Dr. N.K. Anant Rao submitted its report in 1981. Most of the recommendations of the committee pertaining to curriculum revision were accepted.

The Third Dean's Committee headed by Dr. Kirti Singh was set up by ICAR in 1991. The committee constituted sub-groups, which organized workshops involving Deans and senior faculty members from various colleges, who after thorough studies recommended the course structures for degree programmes. The recommendations were accepted for implementation in 1996 by the Vice-Chancellors' Conference.

For the last 50–60 years, the implicit goal of the plant protection curriculum has been to educate agriculture students in all aspects of plant pest control that will make them capable of handling pest management measures immediately after graduation. This goal is now outdated. The aim should be to produce agricultural graduates with a strong background in modern science, biology of pests, principles and techniques of Integrated Pest Management (IPM) and macro/micro-economy relating to pest management, so as to improve sustainability in agricultural production and to protect the environment. The educational system should be capable of producing competent plant pest management experts. This is particularly significant in the context of professional technical manpower requirement; professionals who not only can keep abreast of developments in plant pest management technologies but also capable of sizing up any pest management problems and challenges and suggest possible relevant solutions. On 30th April, 1998, the Joint Meeting of Deans of all Faculties formed faculty-wise groups to examine this matter for undergraduate programmes. Course curricula and course outlines were fine-tuned after going through several exercises and later placed before the meeting of Accreditation Board held on 28th September, 1998.

CURRICULUM DEVELOPMENT IN AGRICULTURAL UNIVERSITIES AND RELATED INSTITUTES

The main aim of restructuring course curriculum according to the Swaminathan Committee on Education for Agriculture (1997) was to re-orient educational and research programmes to meet the challenges of sustainable agriculture. Such a restructuring will involve training of students in the principles and practices of pest management and also for employment generation. The education should equip students to meet the challenges in the 21st Century. With intensification of agriculture and threat of destabilization to ecosystem, the theoretical understanding and practical training of graduates in pest management technologies must be appropriately matched.

Some graduates may go for post-graduate education and pursue a career of research and teaching. Some may opt to work with the State Departments of Agriculture while others may undertake practical consultancies or run agri-business enterprises in plant protection. However, the glamour of government jobs still dominates, although the private sector has in recent years begun to absorb the graduates in a big way. The global opportunities for export of Indian agricultural produce also offer new avenues. Because of the stringent regulations of importing countries with respect to pesticide residues, there is created a greater scope for precision and prescription farming, where adoption of IPM technology with minimal use of pesticides becomes crucial.

It is necessary to develop and promote the use of ecologically sound pest management practices in the interest of sustainable farming. Undergraduate students must therefore be guided to have the basic understanding of this and to have a broad-based education. Specialization at this level will only fail to match the field demand since the graduate will be expected to cater to the overall and diverse plant protection needs of the clients.

Post-graduate education in plant pest management needs to be re-structured to meet the occupational demand and absorptive capacity of the economy. Generally, very few of the graduates enter into research and teaching. Most remain in occupations where all-round knowledge of plant pest management is needed for the jobs. Specialisation offered at the post-graduate level are by and large needed mostly for jobs in research and education sector.

Keeping these points in view, the ICAR's Education Division has recommended new course structure for B.Sc. (Agri.) and B.Sc. (Hort.) students. The important feature is that students must be involved in RAWE (Rural Agriculture Work Experience) where a student has to do practically all farm operations while staying with a farmer in a village. However, subjects such as Nematology and Weed Management were still neglected.

At the post-graduate level the committee under the chairmanship of the Dean, Post-graduate School, IARI, is currently examining and restructuring the courses and syllabi for M.Sc. and Ph.D. in Entomology, Plant Pathology and Nematology.

CURRICULUM DEVELOPMENT FOR IPM TRAINING

There are many definitions of IPM. Recently, Kogan (1968) defined it as "a decision support system for the selection and use of pest control tactics, singly or harmoniously coordinated into a management strategy, based on cost/benefit analyses that take into account the interests of an impacts on producers, society, and the environment". The philosophy of integrated management of pests, diseases and nutrients provides the key to successful farming with sustainable yields. Agenda 21 of the UN Conference on Environment and Development at Rio de Janeiro in June 1992 identified IPM in agriculture as one of the requirements for promoting sustainable agriculture and rural development.

The need for sustainability without impairing the ecological balance and the shift from the paradigm of chemical (pesticide) control to natural control has brought in the concept of IPM. Initially, the concept originated with the early success of classical biological control. Later, this was blended with other methods of pest control to contain the pests more effectively. This resulted in the origin of the concept of integrated control during the 1950s. The idea of managing insect pest populations was proposed by Geier and Clark (1961) who called the concept as "Protective management of noxious species" for pest management. In India, the concept owes its origin to Dr. S. Pradhan who first proposed Integrated Pest Control (IPC) as utilizing the combination of different methods of pest control. Later the concepts of economic threshold level (ETL) and economic injury level (EIL) for decisive control measures were incorporated and the term "control" replaced with "management". The aim was to keep the pests below the ETL and manage them without impairing the yields. The strategy to "kill all" gave way to the concept of "live and let live"

Effective implementation of IPM depends on firm commitment of extension personnel. Since, the IPM concept is still not widely understood in the country, constant in-service training will be required to motivate scientists, teachers, extension personnel and farmers.

There is greater need to provide training for personnel from the SAUs, as they in turn have to organize training programmes for extension functionaries from the Department of Agriculture. Such training activities are presently organized by the Crop Research Institutes of ICAR and the National Centre for Integrated Pest Management for a period varying from 1–4 weeks. The subject matters of such courses include mostly the basic concepts and philosophy of IPM, different pest management techniques used and some special topics in the new frontier areas. Efforts have been made to ensure participation of the various faculties so as to achieve an effective integration of the different disciplines.

The extension personnel from State Governments receive training from the Crop Research Institutes as well as the National Plant Protection Training Institute (Government of India) at Hyderabad. A number of courses are organized for the trainees. The course curricula are also periodically revised and updated in consultation with experts from different fields.

The curriculum for training farmers is simple with more emphasis on skill development. It however differs in contents from state to state. Examples of some of the important topics included in the training are identification of friendly insects and crops pests, methods to protect the population of natural enemies, safe ways of handling pesticides and need-based use of safe and eco-friendly biopesticides or botanicals.

THE FUTURE

Plant pest management in future will demand the knowledge on all aspects of pests, and therefore, discipline-oriented graduates or post-graduates will have many limitations in practising IPM. Farmers will be more interested in prediction of outbreaks so that precautionary measures are taken in time. The new course curriculum will need to include topics such as Prediction and Forecasting, Pest Risk Analysis (PRA), Quarantine Laws, Use of Transgenics in IPM, Pest Management in Protected Horticulture and Poly-House Cultivation, Mass Production of Bioagents and Biopesticides, Application of User Friendly IPM Software, and Linkages with PRA and Geographic Information System (GIS) to better enable graduates to deal with problems and issues when they enter into the general employment. At the Ph.D level, specialized topics in selected subjects may help in creating the trained manpower for future research assignments.

Presently, the emphasis is still discipline-oriented whereas field problem demands a commodity-based approach since farmers are generally interested in protecting his crop in the field from a wide range of pests, such as, insects, diseases and nematodes. In the future, a holistic approach in IPM that involves interdisciplinary understanding will be needed. But formulation of such a programme may create working difficulties for the current students in the future as they may find themselves inadequate with the present discipline-oriented degree from the academic institutions. However, he/she may have better prospects as a consultant.

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PEST MANAGEMENT COURSES IN INDONESIAN UNIVERSITIES AND COLLEGES

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ABSTRACT

The development of Integrated Pest Management (IPM) courses in Indonesian universities and colleges started at the same time as the implementation of IPM programme on rice following the outbreaks of brown planthopper in the late 1970s. IPM, considered the best option, became obligatory because the unilateral approach of using chemical pesticides has failed and has many negative effects.

Today, after a 20-year history in Indonesia, IPM courses form the primary vehicle for disseminating IPM principles and technologies. Close linkage between the courses and field practices provides the students with both theoretical knowledge and practical skills. The multidisciplinary and holistic approach makes the IPM courses particularly attractive. These IPM courses are expected to assume even greater importance in the future as the general population becomes more aware of the environmental issues concerning food production and the associated problems of using pesticides.

INTRODUCTION

The development of pest management courses in most Indonesian's universities started at about the same time with the development of Integrated Pest Management (IPM) programme implementation and practice. Back in 1980, after the long struggle with rice brown planthopper which badly incapacitated Indonesian's rice production, it became apparent that a new approach of controlling pests on rice, the main food crop with the biggest area in Indonesia, should be applied without complete dependence on a single control method. That year, the Indonesian's Department of Agriculture, in particular the Directorate General of Food Crop and The National Developmental Planning Board, in cooperation with several leading universities, launched the IPM pilot projects in five different provinces. This was to obtain more information of such pest control programme before a more widespread measure is to be implemented. The Department of Plant Pest, Faculty of Agriculture, Gadjah Mada University (GMU) of Yogyakarta, Indonesia was one of the universities supervising the programme. Others were Bogor Institute of Agriculture (IPB), Brawijaya University, University of North Sumatera and Hasanuddin University. Following these “pioneering” activities, IPM on food and horticultural crops was developed. Since then, there are millions of farmers and thousands of field officers trained in IPM, although these numbers reflect only a small portion of the vast number of farmers in Indonesia (Oka and Suhardjan, 1997).

At about the same time in 1980, the late Mr. Ir. Samino Wirjosuhardjo, a senior lecturer in the Plant Pest department of GMU, was appointed the director of the Estate Crop Protection Directorate, then a newly established directorate in the Directorate General of Estate Crops, Department of Agriculture. The approach taken by Mr. Wirjosuhardjo, especially to protect smallholder estate crops, was integrated control measures with emphasis on natural control. This approach was emphasized since biological control in estate crops in Indonesia has a long and successful history. Also, at that time the biocontrol approach was badly neglected. He started by making an inventory of the natural enemies on diverse commodities, such as coconut; tobacco, cotton, coffee, tea and others. These were done in joint surveys with other universities. Based on these and other related information, a pest control strategy in smallholders' estate crops was developed. Also, a lot of field laboratories for biological control were built in several provinces, many of which are still functioning today.

As new programmes were developed, the need for more competent, able and skilled human resources on IPM, including those with college degrees, became increasingly essential. GMU realized that courses on IPM were lacking. At that time, students had to integrate basic knowledge and skills of crop protection into a working concept of IPM by themselves, or only with minimal guidance. This was a task that may be both intellectually and practically too hard for them. Therefore it was imperative that a course to introduce and integrate knowledge on pest control be established so that students would be able to familiarize themselves with IPM concepts and practice.

The need for IPM implementation increased as it was realized that using pesticides as insurance for better harvest could be hazardous. The unilateral approach of using pesticides was practised widely in almost all commodities, whether they were rice, food and horticultural crops, or estate crops. Oka (1994) found that pesticide use in Indonesia was starting to become a problem and needed a thorough attitudinal change amongst the farmers. The introduction of IPM programme should change farmers' perception in pest control and might improve the deteriorating condition not only in agricultural land, but also in other areas. The Government, although still obsessed with increasing rice production through programmes that conflict with IPM, was actually supportive of IPM implementation. In 1986, the Government issued a Presidential Decree to restrict pesticide use in rice, and later in 1992 passed a Bill stating that pest control applied in agriculture must be done as an IPM programme (Untung, 1993).

Guided by the Presidential Decree and the Bill, agricultural colleges and universities in Indonesia became the disseminating agents for progressive and innovative scientific inquiries on agriculture. More specifically, they played a key role in plant protection to establish a firm and competent ground for IPM in all commodities for the welfare of the society. As a human resource provider, the university mission was to spread the concept and impart the knowledge and skill of IPM to students, as well as, to help technical agencies maintain their level of competency in IPM. GMU has done this task since the late 1970s, resulting in numerous plant protection personnel achieving deep understanding in IPM. But, since the growth of IPM knowledge is never ending, IPM transfer will remain dynamic and never ceases.

HISTORY OF PLANT PEST MANAGEMENT CURRICULUM

IPM courses in GMU started when Dr. Kasumbogo Untung returned from his study leave in Michigan State University in 1979. With very little help, he single-handedly established the IPM courses, putting together the scattered but related basic and applied agricultural entomology courses offered by the Department of Plant Pests. Prior to his return, the courses offered were excellent with a lot of practical exercises. But most of these did not relate to one another. Students usually had hard times to figure out the concept of pest control in an integrated manner because these courses were generally developed and offered independently. With a course called “Integrated Pest Control”, Dr. Untung introduced the principles of pest control as a holistic concept. He guided his students to new and up-to-date information on IPM, including how to develop, implement and sustain IPM programmes that take into consideration biological control, ecological and socio-economic factors. The course was also well supported by practical exercises since during that time the IPM Pioneer Project on Rice was also implemented in Yogyakarta and

Central Java under the supervisory care of the Department of Plant Pests. Students experienced both classroom and field IPM knowledge and skills.

Subsequently, from this initial course a more comprehensive and focused course was evolved. Taking advantage of the field practice and IPM implementation programme on rice and other food/horticultural crops, Dr. Untung wrote a textbook to accompany the course. He also requested Professor Harjono Semangoen to teach the plant pathology component so as to have a more rounded IPM course. Both Drs. Untung and Semangoen taught the course by combining field experiences and theoretical insights. Most of their students felt satisfied, as the course helped them greatly to understand IPM. In the early 1990s, Dr. Edhi Martono joined the IPM teaching team after his return from his study in the USA. Dr. Martono introduced IPM field excursions and practical exercises. These additions were also what Drs. Untung and Semangoen had earlier desired but were too busy to undertake the outdoor exercises.

Today IPM has grown into one of the most popular courses in the Faculty of Agriculture. It is a mandatory course for students majoring in Plant Pest and Disease. The practical exercises sometimes are conducted using the Field School method of IPM extension. This involves students making observations in the field, discussing the results, and making decisions concerning the pest control measures and other related issues. The only difference from what farmers are doing is that the students do not have to tend the farm. The exercises also include visits to field laboratory for Pest and Disease Monitoring and Forecasting, meeting and discussing with farmers/farmer groups, class discussions and report writing. Beginning this year, Plant Pathologist Dr. Nursamsi Pusposendjojo will replace Dr. Semangoen who will be retiring.

In the first year of IPM development, Dr. Untung received abundant support from the late Ir. Samino Wirjosuhardjo who, as the director of Estate Crop Plant Protection Directorate, had a lot of information and plans for the Directorate. However, he was not able to conduct the class in Yogyakarta since he was staying in Jakarta. Mr. Wirjosuhardjo went as far as to establish a "S1 Plus" programme that aimed at enriching the graduates of the new Plant Protection discipline with both theoretical and practical knowledge and skills for one year, thereafter assign them to different provinces as pest management officers in local estate crop agency. The courses given during their additional year dealt with technical matters, such as Parasites and Predator Rearing Techniques, Natural Enemies Field Management, Sampling and Observation Techniques, Laboratory Methods for Insect Pathogen, and others. However, there were also some courses that addressed the more theoretical aspect of pest management, such as Pest Control Analysis and Decision-Making, Introduction to System Analysis, Statistical Data Interpretation, and others. Graduates from this programme were placed in provinces outside Java, and later to be involved in establishing biological control laboratories in their respective locations. Their contributions toward IPM development in estate crop commodities were important and were deeply appreciated by many working in estate crop plant protection. Unfortunately, this programme was terminated after its third year of operation, as the Directorate thought the number of graduates from this programme was already sufficient.

In 1979, GMU established its Graduate Division, and Plant Pest became one of the programme studies offered. In this programme study, courses closely related to IPM were offered, namely, Advanced Pest Management, Economic Analysis of Pest Control, Sampling Techniques and Pest Control Modelling. In running these courses, it was clear that GMU was highly committed to the cause of IPM. Graduate students also had the advantage of having Dr. Ida Nyoman Oka, a prominent scientist in Indonesian IPM implementation, as one of the lecturer during his tenure in GMU (1991–1997). He taught the Advanced Pest Management class, and impressed the students with his deep insights in IPM. Presently, Advanced Pest Management and Sampling Techniques are required courses for graduate students. Two others are electives taught by Dr. Untung and an Agricultural Economist, Dr. Slamet Hartono. However, in the last five years, these electives were not taught because Dr. Untung also simultaneously held an office in Jakarta in the State Ministry of Environment. Moreover, the number of students wanting to take the courses was few.

REFORM OF CURRICULUM AND ITS LINKAGE WITH PRACTICE

Each IPM course given in each semester is unique in the sense that although the basic principles remain the same, every new term brings about changes in the practice of IPM with new insights gained from problems encountered in the fields. This was possible since the field implementation of IPM programme was often done together with the university as part of the consultative team. The close relationship of the university and the executing agencies and other related groups (e.g. local Agricultural Offices, both provincial and regional; field laboratories; IPM task forces; farmers' groups; individual farmers) has proven to be very beneficial, particularly for everyone who was involved. Because of this involvement, the university was always aware of the IPM progress, thus making it easier for research of the university to better address the current problems encountered in the field. Sometimes, the university also helped as an extension agency. As a result, the IPM curriculum in the university can be kept up-to-date and revision done while the IPM courses were being conducted.

There was also some minor change made in 1994 when the Department of Education, through its Agriculture Science Education Commission, drafted an obligatory and uniform syllabus for all Plant Pest and Disease departments in universities. No change was made to the course content, except for the name change to IPM course from that of “Pest Control and Habitat Management” (Anonymous, 1996). The name change was more for administrative and bureaucratic purposes.

The close relationship of the course with IPM practice was also made possible with the help of many field officers, most of whom were graduates of GMU and who were very willing to help their fellow students. They opened their laboratories for visits and access to information, as well as, provide space and location for research on IPM components or other IPM related topics. IPM extension for farmers, which was in the form of Farmer Field School (FFS), also provided an excellent opportunity for the students to familiarize themselves with the process of introducing IPM programme at farmer level. Students often used this opportunity for their special topic studies or even thesis research. Up to 1997, there were 61 Bachelor Degree thesis on IPM-related topics (Martono, 1997). In the last three years (1997–1999), there were seven more students' research, with three of them investigating the socio-economic aspect of IPM in rice and vegetables. Through these investigations, students were made to realize that all aspects of IPM were equally important, including those not concerning the biology and ecology of the pests.

Practical exercises in IPM for graduate students were more in the form of visits, discussions and interviews with farmers or IPM officers. Students would visit and attend farmers' meetings, observe farmers' method of examining and monitoring their fields, listen to farmers' discussion and decision-making process, evaluate farmers' activities and write reports. Although this exercise was similar to that assigned to undergraduates, these students were expected to give in-depth reports and more philosophical treatise to what they had observed or learned in the field. Following the report, students were asked to hold class seminars where they will discuss the outcome of the field exercises. These exercises made the students alert and watchful for positive traits needed in IPM programmes and at the same time training them to implement IPM efficiently with farmers.

The relationship between the IPM course taught and the real-life condition is very close, since the teachers for IPM courses have hands-on experiences. Today, they are still deeply involved in many research activities and IPM extension services. The close relationship is also maintained with researchers from other research institutions, officers of IPM task forces, and with field workers and their coordinators. These conditions have been very conducive for introducing IPM to the students. Textbooks for the IPM courses in Indonesian are also available; one by Dr. Kasumbogo Untung (1993, currently under revision) and the other by Dr. Ida Nyoman Oka (1994). Other textbooks in English include "Integrated Pest Management" (1984) by Flint; "The Principles of Pest Management" (1987) by Metcalf and Luckman; and "Entomology and Pest Management" (1990) by Higley, Karr and Pedigo. Scientific journals, periodicals, and numerous proceedings, both in Indonesian and English, are also available for the students.

EXAMPLES IN OTHER AGRICULTURAL UNIVERSITIES IN INDONESIA

According to documented record, GMU is the first university to offer courses on IPM. Next was Bogor Agricultural Institute in the early 1980s, with IPM still being offered today. Later, IPM courses were offered by almost all universities with Plant Pest and Disease departments. By 1994, the course was obligatory for all colleges and universities under the heading "Pest Control and Habitat Management".

For private universities in Yogyakarta, where GMU is located, the IPM concept was quickly adopted since most of the teachers of Plant Protection were either from GMU or other past GMU graduates. Through these courses, private universities also played important role in disseminating IPM concept. Some even undertake research supporting IPM programmes, such as those on botanical pesticides, insect pathogens, planting techniques, multiple cropping system, and others.

The IPM courses in some universities are currently under development with help from the more experienced universities. For example, Surakarta State University is under the supervision of Bogor Agriculture Institute. In the past, GMU has supervised three other universities that are now able to conduct the IPM courses themselves.

The course given in Bogor Agriculture Institute is aptly named Integrated Pest Management for S1 (undergraduate) and Advanced Integrated Pest Management for S2/S3 (graduate). The courses, given with practical (exercises), are of three credits. Field exercises include on-farm observation from nursery to harvest, requiring about 3–4 months (13–16 weeks). These exercises are essential to provide students the experience of IPM practice and to have the correct perception of an IPM programme in operation.

PROSPECTS

The development of IPM needs competent and able human resources with good knowledge of the technical aspects of pest management, including its philosophy, vision, mission, purposes, target and outcome. Such skills and knowledge could only be transferred by those who understand these, both in theory and in practice. Universities and colleges, where most of the principles of pest management are studied, are thus indispensable for IPM programme implementation since they have the resources to accomplish the tasks. On the other hand, the IPM approach is an essential part of crop management. As such, IPM courses should in future be an integral part of agriculture training.

There are obstacles and constraints to IPM implementation. For instance, Oka (1989) noted that farmers have become used to relying excessively on pesticides while extension services for IPM were inadequate and lacking in IPM understanding. These weaknesses were partially overcome after FFS was launched to train farmers in IPM. Universities and colleges played a key role in the launching by providing instructors and the training materials (Martono and Semangun, 1996).

Untung (1995) pointed out that there were still institutional constraints when one considers the need to effectively institutionalize IPM in the present system of agricultural development in Indonesia. These constraints include different perceptions of IPM even by people who are in charge of agriculture. There are conflict of interest between IPM and rice intensification programme, too many strong sectorial interests, difficult bureaucratic system, research is mostly discipline-oriented rather than multi- or trans-disciplines, and difficulties in empowering farmers who are mostly illiterate or of low educational level. To overcome these constraints, a strong political will from the government is needed. This is necessary for large-scale implementation of IPM and for sustaining agricultural development. However, it should be kept in mind that the political will cannot be achieved without sufficient IPM knowledge and understanding from the government executives and decision-makers. Therefore, here lies the importance of universities and colleges to impart the required knowledge and understanding that are crucial to effect the political change.

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PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT IN INDONESIA

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ABSTRACT

The overuse of chemical insecticides in Indonesia has resulted in many undesirable problems, one of which is pest resurgence. For example, most of the rice crops in Java suffered serious attack by the brown planthopper in late 1985. To fight this problem, the Government passed the Presidential Decree No.3-1986 that banned the use of 57 registered brands of broad-spectrum insecticides on rice. This policy was strengthened with Law No. 12-1992 on Plant Culture System. The latter established Integrated Pest Management (IPM) as a key plant protection strategy and also made IPM the responsibility of the community and the Government.

In the follow-up activities, the National IPM Programme (Phase I and II) conducted many training courses to make participants (field pest observers, field extension workers, others) become experts in IPM. Curriculum was developed for each kind of training in order to achieve the respective goal. Over time, various aspects of the IPM training curriculum were improved and integrated with that of the National Agriculture University, so that the trainees have the opportunity to obtain a Diploma 1 (D-1) Programme in IPM. In 1993, this facility was extended to the Agriculture Extension Academy (AEA). The IPM curriculum was improved further and adopted by Bogor AEA and many other AEAs in 1997. Graduates become experts in both the contents and the processes and are capable of growing a healthy crop.

Besides rice, there is urgent need to also develop suitable IPM training curricula for other crops, such as, leafy vegetables, fruit vegetables, tuber vegetables, annual fruits, ornamental plants, medicinal plants and post-harvest products. Other general and related aspects (e.g. management) need also be included.

Currently, the political and economic conditions in Indonesia have posed constraints to IPM development and implementation. Nevertheless, efforts are made to continuously upgrade the curricula, though these may differ slightly for each region.

INTRODUCTION

First of all, I like to congratulate FAO-RAP for organizing this important consultation to help the participating countries in developing plant pest management curriculum.

We know that plant pest management is one of the essential activities in farming/farm business. Initially, this was a very simple activity. But due to advancing knowledge in pest biology and ecology, advances in pest management technologies and progress in other related and supporting science, the pest control methodology has become quite complex and requiring a wide and deep understanding of the subject.

Since the discovery of synthetic organic pesticides in the forties, the use of chemical pesticides has increased significantly, largely because of their good controlling effects on many kinds of pests as well as found economical favourable. This has resulted in many farmers becoming dependent on chemical control and often overdosing their crops. Consequently, the quantity of pesticides used in rice production in Indonesia has increased substantially from 1972–1990.

When applying pesticides in a prophylactic manner, farmers need not have to determine the level of pest infestation. Every insect in the field is assumed a pest and should be destroyed as soon as possible with pesticides. Research has shown that such an approach has many undesirable problems, such as:

- pests soon develop resistance to the pesticide in use
- resurgence of pests caused by pesticides may occur
- useful natural enemies (predators and parasitoids) of pests are destroyed
- destruction of other beneficial insects (e.g. bees, pollinators) and non-target species (e.g. earthworms, scavengers, frogs, snakes, birds)
- killing of fish in ponds and in the rice fields
- human health hazards, e.g. acute and chronic poisonings, including deaths

The above problems have led entomologists to develop Integrated Pest Management (IPM) to help overcome or minimize the use of pesticides. IPM has been defined as "a system of pest population control that combines all kinds of suitable pest control measures in a compatible manner to reduce the population of a pest and maintaining it below the economic threshold level (ETL)."

In the early period of IPM development, the integrating components were mainly biological and chemical control. However, other methods of pest control, including the use of appropriate plant cultivars were subsequently incorporated into the system. In Indonesia, an important task of the National IPM Programme is to help farmers and the agricultural community adopt and practise IPM to achieve high crop yields and sustainability in crop production.

HISTORY OF PLANT PEST MANAGEMENT CURRICULUM

In 1984, Indonesia succeeded in reaching self-sufficiency in rice. However, in 1985, almost 70 % of the rice fields in Java were damaged by the brown planthopper, including the high yielding rice varieties Krueng Aceh and Cisadane. The brown planthopper outbreaks were due to intensive use of broad-spectrum insecticides. This incident led to the Presidential Decree No.3-1986 that banned the use of 57 registered brands of broad-spectrum insecticides on rice. Only a few narrow-spectrum insecticides were allowed. An IPM policy as a plant protection strategy was also established. This was firmly backed up by the Law No.12-1992 on Plant Culture System. The latter required plant protection to adopt IPM and the community and government to be responsible for it.

To implement IPM in farmer communities, the National IPM Program was established. Small-scale training conducted since 1986–1988 showed that IPM was both productive and cost-effective. The National IPM Program Phase 1 (1989–1993) has therefore been continued into Phase 2 (1993–1998) with the following main activities:

- IPM training
- IPM implementation
- Undertake research to support IPM
- Continuous IPM evolvement and development

Some of the IPM training activities have included the following: (1) Basic training for field pest observers (e.g. rice IPM, FFS and IPM of secondary crops), (2) Training-of-Trainers (TOT) to become Field Leader (FL I) and Field Leader II (FL II), and (3) Orientation training for field extension workers by FL I and FL II.

To equip Field Extension Workers with the right skills and expertise in IPM, there was a need to develop a sound curriculum for each kind of training. In general, the subject matters and field guides or requirements were different for each kind of training activity. This was because there were many different crops and conditions, pests and diseases, and also many different farm activities. Table 1 gives an idea on what were included in the training activities.

Table 1. Number of topics and field guides in different kinds of IPM training in Indonesia

Kinds of IPM training	Topics	Field guides
Rice	8	44
Secondary crops	6	38
Farmer Field School	8	32
Training-of-Trainers	5	12

For IPM training programmes since 1989, the curricula have always been prepared well ahead to ensure that the goal of the training can be achieved. Table 2 provides an example of the curriculum of IPM-FFS for rice.

Table 2. Rice IPM Curriculum in Indonesia.

No.	Subject Matters	Field Guides
		1. What is sampling?
1.	Sampling and Field Assesment	2. Sampling Method that Use Counting.
		3. Accurate Estimation.
2	Economic Threshold Levels	4. What is the Economic Threshold Levels?
		5. Between Economic Threshold Level and action
		6. Ecological Function Of Organism
3	Ecosystem Analysis	7. Ecosystem
		8. Weekly Ecosystem Analysis.
		9. Weekly Ecosystem Analysis Question.
		10. Rice Seedling Anatomy
		11. Tillering Ability during The Vegetatif Phase.
		12. Roots And Plants Vessels
		13. Leaves Before and After Primordia Initiation
4	Anatomy Of Rice Plant	14. Primordia Anatomy
		15. Booting Stage.
		16. Heading and flowering Stage
		17. Milky Stage
		18. Dough Stage
		19. Mature Stage
		20. Rat Population Growth
		21. Rat Poisons: Zinc Phosphit and Anticoagulants
5	Rats	22. Prevention Of Rats.
		23. What to do about Rats?
		24. Materials to Focus on Rats.

6	Insects And Natural Enemies	25. Insect Collection
		26. Insect Zoo
		27. Spiders
		28. Life Cyclesand Food Web
		29. What is a Predator?
		30. What is a Parasite?
		31. Being A Natural Enemy.
7	Rice Disease	32. Disease Collection
		33. Prevention Of Disease
8	Poisons in Rice	34. Carbofuran, Carbamat Spray and Spiders.
		35. What is an LD 50?
		36. Poisoning Symptons
		37. Demonstrating of Pesticide Poisoning
		38. Pesticide Calculation.
		39. Poison Sprayer Maintenance
		40. Spraying
		41. Evolution in the Rice Field
		42. The Resistence Game
		43. What is This?
		44. Fertilizing

THE REFORM OF CURRICULUM

IPM training curriculum has been integrated with the curriculum in the national university to enable Field Pest Observers and opportunity to obtain the Diploma 1 (D-1) Programme in IPM. After training in rice IPM, FFS and IPM in other secondary crops, the Field Pest Observers can undertake additional courses for one semester in the D-1 Programme in IPM at the National University. This D-1 Programme in IPM is carried out in the following national universities:

- IPB Bogor
- UNHAS, Ujung Pandang
- UGM Yogyakarta
- UDAYANA, Denpasar
- USU Medan
- UNAND, Padang
- UNIBRA Malang
- UNILAM, BandarLampung.

Table 3 gives an example of curriculum of the D-1 Programme in IPM used in IPB Bogor.

CURRICULUM DEVELOPMENT IN AGRICULTURAL UNIVERSITIES
AND RELATED INSTITUTES

Despite successes achieved from IPM training, there are many problems that farmers still need to solve. The National IPM Program therefore increased its activities in the following areas in 1993:

IPM development for highland vegetable crops (cabbage, tomato and potato) and low land vegetable crops (shallot, white onion, chili).
IPM-FFS for secondary crops (mainly soybean)
IPM training at the Agriculture Extension Academy (AEA)

IPM development for estate crops

The first IPM training in AEA was conducted in Bogor AEA in August 1994. Subsequent ones were carried out in Yogyakarta AEA, Gowa AEA and Medan AEA. The purpose of the IPM training in the AEA was to train Field Extension Workers. The IPM training period in Bogor AEA was of three years from 1994–1996. Due to the programme's success, the IPM curriculum is now integrated into the curriculum of AEAs. This IPM curriculum is as given in Table 4.

Table 3. List of Academic Value of Student.

Education and Culture Department
Bogor Agricultural Institute

List of Academic Value of Student

Name :	Dadang Sulaeman
Nomor :	J.0790.136
Place and Date of birth :	Bandung, 24-08-1963
Year as Student :	1990
Faculty :	Agriculture Politehnique
Field :	IPM
Date of Pass :	30-03-1991
Certificate :	Diploma 1 No. 0111910202

No.	Subject Matters	Year 1989/1990			
		QA	**QN**	**C**	**Q**
1.	Religion	B	3	2	6
2.	Pancasila/The Five Principles	B	3	2	6
3.	Agricultural Climatology	B	3	2	6
4.	Agronomy	B	3	4	12
5.	Agriculture Extension	B	3	5	15
6.	Principle of IPM	B	3	2	6
7.	Principle of Plant Pest	B	3	4	12
8.	Principle of Plant Disease	C	2	4	8
9.	Weed	B	3	3	9
10.	Pest and Disease Observation Tehnique	B	3	4	12
11.	Biological Control	B	3	5	15
12.	High Yield Variety and Cultivation Control	B	3	3	9
13.	Pesticide and Application Tehnique	B	3	3	9
14.	IPM Field Practise	B	3	5	15
Cumulatif				48	140

Number of Total Credit : 48
Quality Value of Average Cumulatif : 2.92

Explanation:

QA : Quality Abjad
QN : Quality Number
C : Credit
Q : Quality
A : Excellent
B : Good
C : Fair
D : Pass

Bogor, 31 March 1991
Certified by Chief of Academic and Student Bureu

Ir. Abubakar Burniat
NIP. 130.524.788

Table 4. Curriculum in 1995.

University : Bogor Agricultural Extension Academy
Field : Agricultural Extension

No.	Subject Matters	Semester	Semester Credit System		
			Total	Theory	Practise
1.	Religion	I.	2	2	0
2.	Pancasila/The Five Principles	I.	2	2	0
3.	Indonesian	I.	2	2	0
4.	Agricultural Climatology	I.	2	1	1
5.	Agricultural Ecology	I.	2	1	1
6.	Rural Sociology	I.	2	1	1
7.	Principle of Communication	I.	2	1	1
8.	Social Psychology	I.	2	2	0
9.	Matemathics	I.	2	1	1
10	Plant Protection	I.	3	1	2
11.	Soil and Fertilizing	I.	3	1	2
			24	**15**	**9**
12.	Nationality	II.	2	2	0
13.	English	II.	2	2	0
14.	Principle of Agric. Extension	II.	3	1	2
15.	Adult Education	II.	3	2	1
16.	Principle of Management	II.	2	2	0
17.	Agricultural Economics	II.	2	2	0
18.	Statistics	II.	2	1	1
19.	Principle of Agribisniss	II.	2	2	0
20.	Nutrition and Family's Health	II.	2	1	1
21.	Media of Agricultural Extension	II.	3	1	2
22.	Field Work Practise I	II.	1	0	1
			24	**16**	**8**
23.	Agricultural Development	III.	2	2	0
24.	Principle of Computer	III.	1	0	1
25.	Rural Development	III.	2	1	1
26.	Technique and Methods Of Agric. Ext.	III.	3	1	2
27.	Agribisniss Management	III.	4	2	2
28.	Field Work Practise II	III.	1	0	1
29.	Mechanization	III.	3	1	2
30.	Foodcrop Production Technology I	III.	2	0	2
31.	Horticulture Production Technology I	III.	3	0	3
			23	**7**	**14**
32.	Farmers Group	IV.	3	1	2
33.	Training Management	IV.	2	1	1
34.	Writing Technique	IV.	2	1	1
35.	Social Research Methods	IV.	2	1	1
36.	Economics Of Agric. Production	IV.	2	1	1
37.	Field Working Practise III	IV.	1	0	1
38.	Food crop Production Technology II	IV.	2	0	2
39.	Horticulture Production Technology II	IV.	4	0	4
			18	**5**	**13**
40.	Programme & Evaluation Of Agric. Ext.	V.	3	1	2
41.	Cooperative	V.	2	2	0
42.	Agricultural Product Marketing	V.	3	2	1
43.	Field Working Practise IV	V.	1	0	1
44.	Seed Technology	V.	3	1	2
45.	Specific Problems	V.	2	0	2

46.	Foodcrop Production Technology III	V.	2	0	2
47.	Horticulture Production Technology III	V.	2	0	2
			18	**6**	**12**
48.	Seminar	VI	1	0	1
49.	Field Working Lecture	VI.	4	0	4
50.	Agricultural Product Technology	VI.	4	1	3
51.	Agricultural Biotechnology	VI	3	1	2
52.	Usage of Agricultural Waste	VI	3	1	2
			15	**3**	**12**
	Total		**120**	**52**	**68**

The Agricultural Extension Education in AEAs is one of the training courses for graduate Field Extension Workers with D-3 certificate. It is not academic but professional in nature, with more practical training than theory. The number of practice hours is as much as 69 semester credits compared to 51 semester credits for the theory.

Graduates from AEAs in agricultural extension are expected to be knowledgeable in both the course contents and processing of information after spending 6 semesters (3 years). Achievement in content area means that they have mastered the capability of healthy crop cultivation, which is the first principle of IPM. The other aspects of the healthy crop cultivation include:

- Choosing healthy seeds from high yield varieties suitable to the agroclimatic conditions
- Good tillage and planting practices
- Good irrigation
- Balance fertilizing
- IPM
- Good weed control

Subject matters that are needed to fulfil the content area are given in the third, fourth and fifth semesters. Every topic is simplified based on relevant studies suitable for application in the field. In the field learning process, students are divided into groups. For each group, there is a lecturer (or assistant lecturer) who serves as a Field Guide. Besides the main subjects, there are also supplementary ones, such as climatology, cooperatives and principles of agribusiness, all of which are studied from the first until the fifth semesters.

In information extension, students are guided on non-formal adult education methodology and group organizational activities. The activities involve real farm conditions during a crop production season.

During the sixth semester, students are involved in Field Work Lecture which is similar to IPM-FFS. This entails close partnership and working together with the farmers. The activities include planning together in group, decision making by group's participants, experience learning cycle, integrating theory and field practice, learning farm instruments and coordinating/scheduling of activities during a production season. To supplement the Field Work Lecture, seminars, exercises on writing and documentation techniques, and regular lectures on other supportive activities are also carried out at various times until the fifth semester.

Table 5 gives the outline of the IPM curriculum.Because of IPM success in Agricultural Extension Field, the Directors of AEAs have given instructions to the Animal Husbandry Extension Field and Fishery Extension Field to adopt the IPM approach by selecting and combining appropriate subject matters in their respective areas of activities.

CURRICULUM DEVELOPMENT IN IPM TRAINING.

The IPM training curriculum consists of rice IPM, IPM of secondary crops and IPM-FFS guided by the following principles:

- Grow healthy crops
- Conserve natural enemies
- Observe the crop weekly.

Table 5. The IPM Curriculum.

University	: Bogor Agricultural Extension Academy
Field	: Agricultural Extension

No.	Subject Matters	Semester	Semester Credit System		
			Total	**Theory**	**Practise**
1.	Religion	I.	2	2	0
2.	Pancasila/The Five Principles	I.	2	2	0
3.	Indonesian	I.	2	2	0
4.	Nationality	I.	2	2	0
5.	Principle of Computer	I.	1	0	1
6.	Rural Sociology	I.	2	1	1
7.	Principle of Communication	I.	2	1	1
8.	Social Psychology	I.	2	2	0
9.	Matemathics	I.	2	1	1
10.	Plant Protection	I.	3	1	2
11.	Soil and Fertilizing	I.	3	1	2
			23	**15**	**8**
12.	Agricultural Development	II.	2	2	0
13.	English	II.	2	2	0
14.	Principle of Agric. Extension	II.	3	1	2
15.	Adult Education	II.	3	2	1
16.	Writing Tehnique	II.	2	1	1
17.	Agricultural Economics	II.	2	2	0
18.	Statistics	II.	2	1	1
19.	Principle of Agribisniss	II.	2	2	0
20.	Nutrition and Family's Health	II.	2	1	1
21.	Agricultural Climatology	II.	2	1	1
22.	Field Work Practise I	II.	1	0	1
			23	**15**	**8**
23.	Principle of Management	III.	2	2	0
24.	Media of Agric. Extension	II.	3	1	2
25.	Economics Of Agricultural Production	III.	2	1	1
26.	Tehnique and Methods Of Agric. Ext.	III.	3	1	2
27.	Seed Technology	III.	3	1	2
28.	Field Work Practise II	III.	1	0	1
29.	Mechanization	III.	3	1	2
30.	Agricultural Ecology	III.	2	1	1
31.	Specific Problems	III.	2	0	2
30.	Foodcrop Production Technology I	III.	2	0	2
31.	Horticulture Production Technology I	III.	3	0	3
			26	**8**	**18**

32.	Rural Development	IV.	2	1	1
33.	Programme & Evaluation of Agric. Ext.	IV.	3	1	2
34.	Farmers Group	IV.	3	1	2
35.	Training Management	IV.	2	1	1
36.	Field Working Practise III	IV.	1	0	1
37.	Agricultural Product Technology	IV.	4	1	3
38.	Horticulture Production Technology II	IV.	4	0	4
39.	Social Research Methods	IV.	2	1	1
40.	Foodcrop Production Technology II	IV.	2	0	2
			23	**6**	**17**
41.	Cooperative	V.	2	2	0
42.	Agribisniss Management	V.	4	2	2
43.	Agricultural Product Marketing	V.	3	2	1
44.	Agricultural Biotechnology	V.	3	1	2
45.	Field Working Practise IV	V.	1	0	1
46.	Seminar	V.	1	0	1
47.	Horticulture Production Technology III	V.	2	0	2
48.	Usage Of Agricultural Waste	V.	3	1	2
49.	Foodcrop Production Technology III	V.	2	0	2
			21	**8**	**13**
50.	Field Working Lecture	VI.	4	0	4
			4	**0**	**4**
	Total		**120**	**52**	**68**

The basic learning features in the IPM training are:

- Rice field serving as the main instrument of teaching and learning
- Experience learning cycle
- Agroecosystem research
- Appropriate methods, materials and technologies
- Curriculum arranged according to the skills needed

Fifty percent of the training time is spent in the rice field as opposed to conventional classroom approach. The experience learning cycle begins with direct observation, experimenting and experience sharing. This is done weekly, together with agroecosystem research and other studies. Every learning activity is supported by appropriate materials/subject matters, which can be applied directly by the farmers. The IPM training curriculum is planned based on developing the skills to make farmers as IPM experts, so that they are able to do IPM themselves and also guide other farmers accordingly. Two main components they are trained to master are the IPM contents and information processing. These are to enable them in making appropriate decisions. Besides rice, the IPM training needed in other crop commodities include:

- Tuber crop (sweet potato)
- Leafy vegetables (spinach)
- Fruit vegetables (tomato)
- Tuber vegetables (potato)
- Annual fruits (melon), Perennial fruits (apple)
- Ornamental plants (rose)
- Medicinal plants

PROSPECTS

Presently, the political climate in Indonesia is still not fully stabilised. The Central Government intends to give part of the authority to the Regional Governments, including the jurisdiction in agriculture. How the changing conditions will affect IPM development in national universities is presently difficult to predict, especially if the allocated budget of the Regional Governments is limited. For Bogor AEAs, the budget is Rp 100 million (about US $ 12,500) a year, with possibly 60 students for each semester. Nevertheless, I am optimistic that the IPM curriculum can be integrated permanently into the curriculum of national universities, especially in Bogor AEAs, for the following reasons.

- The IPM policy is now adopted in all Provinces, because of Law No. 12-1992.
- In almost every region, there are many Field Pest Observers, Field Leader I, Field Leader II and Field Extension Workers who have undergone IPM training.
- In almost every rural area, there are IPM Farmer Leader and IPM farmer graduates.
- The required budget is not too big.
- There are numerous people in the rural communities with strong interest in IPM.

However, the performance of IPM training will differ from region to region, depending on the kind and quality of human resources available in the region and the amount of budget allocated.

In conclusion, I would like to express my sincere appreciation to FAO-RAP for inviting me to this Expert Consultation. I also like to request FAO to provide further technical or financial aid to Indonesia, especially in IPM development activities, both through the universities (professional education) or other related institutes (non-formal education), so that Indonesia may be able to continue actively with its development programmes in plant pest management curriculum.

PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT IN MALAYSIA

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ABSTRACT

The Department of Agriculture (DOA), Malaysia is entrusted with the overall role to manage pests of various crops other than the two major plantation crops, rubber and oil palm. Pest management training, a major function, is organized mainly through its in-house training facilities. Because of the need for improvements, the curriculum has changed substantially over time; changing from a formal lecture-cum-field demonstration approach that focused on subject matters (with emphasis on pesticides) to the current format which is less formal, dynamic and using the "experiential learning" methodology to learn Integrated Pest Management. Experience has shown that more than 60 percent of the time must be given to field practice and discussion for the training to be effective.

In Malaysia, the universities are responsible in providing formal training at degree, diploma and certificate levels. From time to time, they provide research findings to support the training activities of DOA. Other related research institutions also provide technical inputs for DOA to keep abreast with new technologies.

INTRODUCTION

The Crop Protection and Plant Quarantine Division (CPPQD) under the Department of Agriculture (DOA) of Malaysia plays an important role in the overall management of pests for crops other than rubber and oil palm. Although it is not the function of the DOA to conduct basic research, it has the responsibility in formulating control strategies through adaptive field research programmes or local verification trials before finally recommending them to the extension personnel and the farmers.

Training has always been a major function of the DOA to constantly upgrade the knowledge and skills of the extension staff. The DOA has several means of conducting staff training at the various in-house training facilities. At the federal level, the Human Resource Development Division (HRDD) plans the overall staff training needs of the DOA. The two major Regional Extension Training and Development Centers (RETDCs), one in the North and the other in the South, are given the task to conduct courses.

There are also various Farmer Training Centers (FTC) at the State level, which are under the jurisdiction of the State Department of Agriculture (SDOA). These training facilities are managed by the SDOAs to cater for the training requirements of the extension staff and farmers. For these training centres, the curriculum is quite flexible and is designed to suit the current needs of the States.

Generally, the technical content of the pest management curriculum is prepared by specialists from CPPQD either at headquarters or by specialists assigned to the States. Teaching methods, programme layout and duration, are proposed and prepared by the people from HRDD, RETDC or FTC, depending on where the training is to be carried out.

The objectives of this paper are:

- To present the curriculum development for pest management training in Malaysia.
- To review how training in pest management has been conducted.

- To contribute and share with this Expert Consultation recent ideas, knowledge and experiences that may help towards formulating a more effective Pest Management Training Curriculum.

HISTORY OF PLANT PEST MANAGEMENT CURRICULUM

The development of plant pest management curriculum in Malaysia can be traced back to two main eras -- Pre-IPM era and the IPM era. The former was before 1980 and the latter after 1980.

The Pre-IPM Era (Before 1980)

Pest problems were addressed rather simply during this period. The major focus was to train on how to use pesticides when there was pest attack. The training method and subject contents were quite similar to those taught to the trainers during their formal training in the college. Basically, the curriculum contained mainly the following pest control subjects:

- **The major insect pests of a particular crop and their control.** This subject covered the bionomics of the important insect pests in great detail. It also included a list of the pesticides associated with their control with a description of their usage.
- **The major diseases of a particular crop and their control.** Likewise for this subject, the main fungi or bacteria were described and the chemicals for their control listed.

Prior to, or during the 1970s, the emphasis was on scheduled pesticide application. Each and every stage of the crop, time of spraying and the recommended pesticides, were described in great detail. Basically, pesticides were considered important inputs in the agricultural production.

The IPM Era (1980 onwards)

The turning point of pest management came after the following devastating events:

1. outbreak of the Brown Planthoppers (BPH), *Nilaparvata lugens*, in 1977 in the Tanjung Karang Irrigation Scheme,
2. outbreak of the Whitebacked Planthoppers (WBPH), *Sogatella furcifera*, in the Muda Areas in 1979, and
3. outbreaks subsequently in other major granary areas of Malaysia.

The DOA, particularly the then Crop Protection Branch, started to re-evaluate the pest management approaches. IPM was given top priority. Rice was the most important crop for introducing IPM by DOA since it was a major national crop and has been well studied both nationally and globally.

The Rice Pest Surveillance and Forecasting System, mooted by the Malaysian Agricultural Research and Development Institute (MARDI) and later developed by the Crop Protection Branch in 1980, became a significant platform for pest management training and a major contributing point for the introduction of the IPM concept. At the same time, it became the basis for subsequent development of pest management curriculum. This was the era when many pest management features were introduced, namely:

1. role of natural mortality factors (natural enemies),
2. early warning system in pest management (surveillance system),
3. Economic Threshold Level (ETL) concept,
4. understanding of the agro-ecosystem (rice ecosystem in particular), and
5. emphasis on various agronomic aspects, such as, crop phenology, water management and land preparation, which later became known collectively as Integrated Crop Management.

THE REFORM OF CURRICULUM

In 1990s, the DOA embarked on a major reform in terms of the approach to improve the pest management curriculum. At the DOA federal management level, there was a general consensus that the knowledge and skills of officers need to be upgraded in view of the fast pace in changes relating to pest management. To achieve this, it was decided that the crop-base approach be adopted instead of the project-base approach.

The crop-base approach played a key role in the development of "technology packages" for various crops in the early 1990s. Every aspect of the crop was compiled into the "technology package". At the same time, Pest Management Specialists in various crops, based largely on their experiences, developed and incorporated the "experiential learning" aspects. This was to enable trainee participants to have the required hands-on experience learning.

The following are some of the technology packages that were developed:

- Fruit crops - mainly durian, mango, dokong and rambutan
- Vegetables - various leafy vegetables and fruit vegetables
- Rice
- Pesticide Application Technology
- Diagnostic courses on fruit crops, vegetables and rice

From time to time the technology packages were upgraded.

CURRICULUM DEVELOPMENT IN THE AGRICULTURAL EXTENSION TRAINING CENTRES OF DOA

Due to the need for a series of technical refresher courses, it was considered necessary that the teaching method be first re-evaluated to suit the demand for a more practical approach. For this purpose, from a study conducted on training effectiveness in the RETDCs, Taharim (1994) suggested that more than 60% of the time spent should be emphasized on practical and field discussion. She also strongly recommended the use of "experiential learning" methodology as the main teaching method. Her recommendation was further strengthened by her findings that 93% of the respondents had increased their knowledge, 87% increased their skills and 88% felt that they were more competent in their work after exposure to the experimental learning method in a pest management course. Anang et. al (1995) also considered this approach important to sustain knowledge, attitude and practice among farmers.

CURRICULUM DEVELOPMENT FOR IPM TRAINING

Guided by the above findings, the discovery-based and hands-on exercises were further experimented on with respect to IPM in rice. Examples of some of these exercises included the following:

- Diagnostic exercises in groups to observe symptoms for better decision-making on whether they were caused by nutrient deficiency, damaged by insect pests or diseases, physiological disorders, or due to water stress.
- Hands-on experience to set up cage experiments to demonstrate and observe the role of natural enemies (e.g. *Lycosa* spider feeding on BPH).
- Experience sweeping with insect nets in rice fields to identify pests and natural enemies to determine their abundance.
- Practical experience in the proper handling of spray equipment, including making their own calibration.

Many IPM-related topics were taught in the Pest Management Course. The following are sample topics for rice based on the needs outlined in the technology package.

- Principles of IPM in rice ecosystem.
- Insect pest and their natural enemies in rice ecosystem.
- Integrated weed control and weed control package for direct-seeded rice.
- The rice pest surveillance and forecasting system.
- No early spray concept in rice ecosystem.
- Incorporation of fish culture and duck rearing in rice ecosystem.
- The role of barn owl as a biological control agent of field rats.

In cases of Fruit Crops and Fruit Vegetables, some of the sample topics included the following:

- Use of mass trapping technique for control of fruit flies in star fruits.
- Early detection and control of patch canker in durian.
- Pruning technique in durian.
- Use of cure-lure and light traps for fruit fly management in fruit vegetables.
- Use of sticky traps for the control of aphid and thrips in vegetables under covered structures.

CURRICULUM DEVELOPMENT IN AGRICULTURAL UNIVERSITIES AND RELATED INSTITUTES

In Malaysia there are three levels of pre-service training, namely, the degree, diploma and certificate level. These are the formal levels of training prior to joining the government or private sector service in agriculture. The requirements for these levels are as given in Table 1.

Table 1. Theory and practical requirements for training at degree, diploma and certificate levels.

Training Level	Theory (%)	Practical (%)
Degree	80	20
Diploma	60	40
Certificate	40	60

Pertaining to agriculture, there are four major universities in Malaysia that offer courses related to Pest Management. These are University Putra Malaysia (UPM), formerly known as University Pertanian Malaysia or the Agricultural University, University of Malaya (UM), University Sains Malaysia (USM) or the Science University of Malaysia, and University Kebangsaan Malaysia (UKM) or the National University. In the last three universities, basic and applied courses in entomology and plant pathology are offered through their Schools of Biological Sciences. Students may do undergraduate, graduate and post-graduate studies in these fields.

At UPM, the Department of Plant Protection was established within the Faculty of Agriculture with the inception of the university in 1973. Plant protection subjects were first taught in the College of Agriculture, the predecessor of UPM. Since then, the department has grown in stature and now boasts a large number of highly qualified and experienced staff with expertise in many areas of plant protection, including plant pathology and entomology.

The excellent facilities in the department, together with the strong research links to national and international institutions, provide an excellent opportunity for interested researchers and scholars, both local and foreign, to advance further their career in plant pathology and entomology. Indeed, most of the officers working in the DOA, especially those working in the Crop Protection and Plant Quarantine Division, were graduates from this university.

The department has made significant contributions to tropical plant protection and is recognized for its work in the areas of biological control of pests and diseases, pesticide application technology, apiculture and pollination, and pest management. Table 2 lists some of the courses offered by this department.

Table 2. Examples of some courses offered at the Department of Plant Protection in Universiti Putra Malaysia.

1. **Entomology** (introduction to morphology and physiology of insects).
2. **Introduction to Plant Protection** (introduction to causal agents, such as fungi, bacteria, viruses, nematodes, etc., including the principles of disease control).
3. **Introduction to Plant Pathology** (disease triangle, classification of disease pathogens, epidemiology and resistance mechanism, use of fungicides).
4. **Plant Protection** (introduction to basic understanding on the science of plant protection, weed science and nematodes, including specific topics on morphology, physiology and ecology, introduction to classification of pests, and basic approach to yield loss assessment).
5. **Principles of Crop Protection** (principles of pest management, bionomics of insect pests and microorganisms (fungi, bacteria, viruses, mycoplasma, nematodes), diagnostic procedures, symptoms and also insect collection)
6. **Introduction to Entomology** (external and internal morphology, physiology, order, family of insects).
7. **Entomology** (ecology, population dynamics of insects, distribution and abundance, bionomics and control of the major insect pests with emphasis on rice and plantation crops).
8. **Plant Pathology** (concepts and principles of plant pathology, disease diagnosis and crop loss assessment, biological diversity and ecology of plant pathogens, applications of biotechnology, such as, tissue culture techniques, genetic engineering, molecular biology and gene cloning in plant pathology).
9. **Principles of Pest Control** (includes theory and practice of pest management).
10. **Pesticide Application Technology** (characteristics, formulation and use of pesticides, nozzle selections, spray equipment, calibration of spray equipment, safety aspects).
11. **Entomology** (emphasis on physiology, behaviour, insect pathology, relationship of insect and disease, population ecology).
12. **Apiculture** (evolution, biology and ecology, principles of bee management).
13. **Plant Pathology** (emphasis on plant pathogenic fungi, taxonomy and physiology; host-parasite relationship, epidemiology and control of the major diseases).
14. **Nematology** (history, morphology, taxonomy, biology, physiology, host-parasite relationship, population dynamics, damage symptoms, classification of tropical and sub-tropical nematodes).

Research institutions, namely, the Malaysian Palm Oil Board (MPOB), Malaysian Rubber Board (MRB), MARDI, and other private research bodies have their own training programmes and curricula. However, these are outside the scope of this discussion. Nevertheless, their research findings are easily accessible upon request. In addition, they also offer specialized training to DOA staff from time to time.

PROSPECTS

With the success achieved so far and the overwhelming support currently given by both management and other senior officers who have undergone pest management training under the latest curriculum, there seems to be no turning-back in the "experiential learning" approach. Although the technological advancement appears to be much faster than what the recipients can consume and adopt, it is hoped that the "experiential learning" approach to pest management will be able to speed up significantly the rate of technology adoption. In the not-too-distant future, it is envisaged that we would need to cope with even more complex concept in addressing pest problems. These would include integrated biodiversity management, plant growth enhancement through fertilizer manipulation to increase plant vigour as a tool in pest management, organic farming, and incorporation of other husbandries such as animals and fish, which collectively has been coined as *total agriculture concept*.

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PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT IN PAKISTAN

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ABSTRACT

Pakistan now has four agricultural universities, six agricultural colleges, one forestry college and two fo`restry research institutes. They offer degree and certificate courses and the curricula are approved through consultation.

In Pakistan, pests cause immense damage to crops. To deal with them, young men are trained in plant protection as an integral part of agriculture courses. The B.Sc pest management course set up in 1961 was built up progressively from the Entomology course, initially offered as a minor subject in 1917 and later as a major one in 1934. Both M.Sc and Ph.D degree courses were also started with the curricula revised towards in-depth research. The theory and practical instructions were also greatly strengthened.

The earlier curricula in agriculture colleges and training institutes (for field assistants) consisted of theory and practical of very basic pest control practices. Later, new aspects were added (e.g. Pest Biology, Crop Behaviour, Host-Pest Interaction, and New Control Strategies and Materials). More recently, the curricula have included Innovations, Environmental Safety, Cost:Benefit Ratio, Pest Control Programmes, and others. Courses in Molecular Biology, Virology, Agrometeorology, Pesticide Chemistry, Biotechnology, etc. were also offered. Integrated Pest Management (IPM) was introduced and became an important course. In addition, field practical on various aspects formed a significant part of the curricula. All these have helped to improve the capability of agricultural workers in identifying pests, pathogens and weeds, and in developing effective control options.

Apart from the public sector, a number of private pesticide companies and one NGO presently conduct training for their staff and the farmers. These courses are usually crop-specific and comprised of pest identification, pest scouting, and pesticide use and safety measures.

IPM, included in the Agricultural Policy (1991), is now considered an essential component of the agriculture production system aiming at reducing pesticide reliance. This has stimulated many agriculture institutes to develop IPM-related curricula for various training levels and of different specializations. Many short and specific training courses have been conducted by institutes/agencies for their workers, who in turn provide training to the farmers. Workshops on IPM in rice, cotton, sugarcane and fruits for researchers, extension workers and progressive farmers are also held from time to time. Some curricula are prepared in collaboration with outside bodies like FAO, World Bank and Winrock International. To keep in line with new developments, the curricula are also upgraded periodically.

INTRODUCTION

Pakistan is an ancient civilization, though its political boundaries were drawn only 53 years ago when it gained independence in August 1947. The territory is a region of diversified terrain, with mountains to the north and west and arid and semi arid expanses in the south and east. In the center is a flat fertile plain fed by the Indus and its tributaries, covering approximately 210,000 sq. km. The geographic area of Pakistan is about 80 million hectares. Out of this, 21 million hectares are cultivated; 16 million by canal irrigation and the remaining 5 million are either rain-fed or tube-well irrigated.

The major pests of rice, cotton, sugarcane and fruit crops in Pakistan are stem borers, hoppers, white fly, bollworms, thrips, pyrilla, fruit flies, mites, molds, rusts, smuts, mildews, rots, stunt, mosaic, bunchy top, inflorescence malformation and several nematodes and weeds. The post-harvest pests include Khapra beetle, red flour beetle and post-harvest rots. The management practices are prevention, observation and intervention, which had hitherto been mostly chemical. Efforts through education to integrate the available control measures have been made and stress was on the preparation of customized curriculum appropriate to the literacy, economic conditions and the other factors.

The great famine of 1876–78 and that of 1900 prompted excavation of irrigation canals and establishment of Agricultural Department on scientific lines in the provinces. The Punjab Agricultural College and Research Institute Lyallpur, (now Faisalabad), the oldest in the country was established in 1906. The post of one Assistant Professor of Entomology was created in 1908 to impart education in plant protection. Over the years there has been increase in the number of Agricultural Research and Teaching Institutions. Now, Pakistan has four Agricultural Universities: two in Punjab, one each in Sindh and NWFP. Also there are six agricultural colleges, two in Punjab and one each in Kashmir, NWFP, Sindh and Balochistan. There is one Forest College and two Forest Research Institutes in the country. The Pakistan Agricultural Research Council through its National Agricultural Research Center, Pakistan Central Cotton Committee through its two Research Institutes and two Research Stations, and the Department of Plant Protection, are working at the Federal level with their IPM programmes. The provinces have their own Research Institutes and Extension Wings of the Agriculture Department for imparting training to the employees and to the farmers.

The various universities, colleges, departments and institutes offer degree and certificate courses and their curricula are discussed and approved through consultation. From time to time, new courses are introduced and the old ones are improved so as to meet the prevalent demand. The curricula are in conformation with the national standard and are usually prepared in collaboration with relevant academicians; local as well as foreign. Advice and support of international organizations are also sought for improvement.

HISTORY OF PLANT PEST MANAGEMENT CURRICULUM

Pests are known to have caused immense damage to crops especially grain crops. Desert locust and brown leaf spot of rice had brought havoc in the subcontinent. To mitigate the effect of pests a number of studies and investigations were made which recommended ways and means to boost agricultural production and reduce losses through protection measures. The protection of crops and stored produce was the cornerstone of agricultural policy. As a sequel to it, Agriculture Colleges and Field Assistants Training Schools were set up to train young men in the subjects of agriculture with plant protection as an integral part of the curricula.

In the Agriculture College at Lyallpur a post of Assistant Professor of Entomology was created in 1908. Initially the college provided a three-year education leading to the Licentiate of Agriculture Diploma. This course duration was extended by one year in 1914 and some attention was given to Plant Protection. Those completing four years were appointed as Agriculture Assistants and students completing only two years course were posted as Estate Managers. In both programmes, Entomology was taught as a minor subject.

A four-year B.Sc. degree course was started in 1917 and Entomology was taught as a minor subject. It was in 1934 that Entomology was introduced as one of the four major subjects covering insect-plant relationship and all measures to overcome pest problems confronted by the major crops. This continued up to 1961 when the college was upgraded to a university. This led to opening of Sections and Departments relevant to pest management and initiation of interdisciplinary programmes through cooperation with the allied sections. M.Sc. and Ph.D. courses were started. The syllabi were revised and in-depth research encouraged. Theory and practical instructions were given side by side. Laboratories were refurbished and libraries stocked with journals, monographs and textbooks as required for the advanced new curricula. This was backed by thorough evaluation of scholastic aptitude. Other institutions in the country likewise progressed with time and made good contributions. The Department of Plant Protection provides training in Plant Quarantine and Locust Survey and Control to its staff and others each year. These were short duration courses and the curricula consist of educational materials in pest biology and control.

Similar developments also took place in other locations. The Agriculture Institute, Sakrand was shifted to Tando Jam and named Agriculture College in 1956 and up-graded to Sindh Agricultural University in 1975. Five years later the Agriculture College at Peshawar became Agriculture University. The Barani Agriculture College at Rawalpindi was upgraded to Barani Agriculture University in 1996. At these places of agricultural learning a number of courses in Plant Protection, including Pest Management, are offered at the under graduate and graduate level.

THE REFORM OF CURRICULUM

The curriculum at the time of independence in 1947, and for about a decade later, was very simple. It was based on concepts, theories and principles derived from observations, investigations and studies with primitive tools, machinery, equipment, books and reference materials that were available then. Developments in all walks of life, including plant protection at home and abroad, were taking place. The rich experiences were absorbed, which triggered decisions and action for reform of the curriculum.

Keeping up with the demand of the time, the College of Agriculture at Lyallpur (Faisalabad) was upgraded to University in 1961. This was the first university in the country. Structural changes were made, new courses were started and some old ones were revised to cope with the needs of the subject areas in the country. The Directorate of Basic Sciences and Faculty of Agriculture were established. B.Sc. degree programme was replaced with a five year B.Sc. Honours course. In the Directorate of Basic Sciences, a Department of Zoology was opened which offered a basic course in Zoology for the undergraduates, while in the Faculty of Agriculture a Department of Entomology was organized for teaching Entomology, especially the latest pest management techniques at the undergraduate and graduate level. The syllabi of the classes were updated and efforts were made to bring them at par with those of the developed countries. Ph.D. degree courses were also started. Likewise, reforms in pest management curricula were also made from time to time in the other agricultural universities and colleges. The Agricultural Research

Institutes at the Federal and Provincial level also made provisions for improvement in pest management in their annual programmes

All this while, efforts have been made to continue to provide quality education in plant pest management. Learned people were inducted, laboratories furnished with state-of-the-art equipment and materials, and plant protection machinery (especially sprayers) were acquired to help run advanced training courses. The curricula have been constantly reviewed and discussed under the aegis of the University Grants Commission, while help and advice from relevant quarters were also frequently sought.

CURRICULUM DEVELOPMENT IN THE AGRICULTURAL UNIVERSITIES AND RELATED INSTITUTES

The ultimate target of agricultural education and training, especially Plant Pest Management, has always been "the man behind the plough" who is a farmer, planter, gardener, orchardist, nurseryman or forester. The farmer in Pakistan is either by profession or by caste, and more so through combination of both. Previously, he was predominantly an illiterate and a subsistence farmer. A positive change has occurred and now he has the will and capacity to receive and respond to instructions in pest control. Instructions, advice and demonstrations by the government functionaries and private company people are generally based on the available knowledge. Also, crop festivals, grow more food campaigns, production competitions, farm visits, training and the other promotional activities have been instrumental in creating greater awareness among the agriculturists. Primarily, the plant protection knowledge source has been the Agriculture Colleges at Faisalabad and Sakrand and the Provincial Agriculture Extension Departments. The earlier curricula in the Agriculture Colleges and Field Assistants Training Institutes consisted of theory and practical of very simple or basic pest control practices. Later, new management practices were introduced through the curricula, such as, advanced courses in Pest Biology, Crop Behaviour, Host-Pest Interaction, and New Control Strategies and Materials. Recently, the curricula have included Innovations, Environment Safety, Cost: Benefit Ratio Studies, Globalization and Harmonization of Pest Control Programmes, and others.

After creation of Pakistan the education in Plant Protection consisted of courses in Botany, Zoology, Entomology, Plant Pathology and allied subjects. Weekly lectures, laboratory practical sessions and small-scale field experiments comprised the curriculum at degree level. The courses were simple but catered to the need of local agriculture. Still simpler were the training programmes for the field assistants who were considered as backbone of the Provincial Agriculture Departments. The courses in Plant Protection were part of a four-year agriculture degree or one-year diploma programme. They have enabled graduate employees to properly advise farmers on healthy seed gathering, selection of disease or pestfree fields, and simple control operations. Much emphasis was given to grain protection. The extension workers were instructed to get rid of Khapra beetle, red flour beetle, etc., by spreading wheat in thin layers for 4 to 6 hours in June-July. Bags must be disinfested by immersion for 15 minutes in boiling water and then expose to sun drying. Rice stubble and cotton sticks were to be removed from the fields after harvest or picking. Use of mercurial fungicides and organochlorine insecticides was introduced, given free and encouraged. Control practices were also considered a must and obligatory. However, little attention was given to the impact on the production system and the environment. Through visits, lectures, and practical, the agriculture employees imparted the same stuff to their subordinates and growers at large.

With the advancement in agricultural sciences the curriculum was improved. It included pest management methods, such as, regulatory, cultural, mechanical, physical, genetic, biological and chemical. Courses in Molecular Biology, Virology, Agrometeorology, Pesticide Chemistry, Biotechnology, etc. were offered. Integrated Pest Control (IPC) came into vogue, which was actually a combination of various control methods with a planned approach. Integrated Pest Management (IPM) then replaced this, which in essence was a farming system with the application of combined control operations compatible with the farm production unit and its social, physical and economic conditions. The course had improved the capability of agricultural workers to identify pests, pathogens or weeds, and to look for control options that are efficient and safe to the environment in the short and long term. The course also included familiarization with diagnostic techniques and pesticide application technology.

Lately, the courses contain findings of sophisticated research in related fields and are based on interactions and phenomena in nature as observed using the finest tools of investigation. It is widely accepted IPM has emerged as a hope for the agriculturists and the farming community at large. It brings into its folds various fields, such as, plant quarantine, ecology, seeds/varieties, crop husbandry, crop rotation, crop protection, fertilization, and others, and blend them together in a harmonious manner. The new courses, therefore, have improved substantially. Some of the course titles include Introduction to Pest Control, Ecology, Economic Entomology, Insect Transmission of Plant Diseases, Plant Nematology, Weed Physiology, Pesticides, Principles of Biological Control, Vertebrate Pest Control, Plant Disease Epidemiology, Pesticide Application Technology, Plant Virology, Biotechnology, Pest Management, Weed Management, Urban and Industrial Pest Management, Pesticide Toxicology and Advanced Pest Management.

The practical work includes collection, preservation and identification of major pests, pathogens and weeds, morphology, anatomy, physiology, study of nature and extent of damage to host plants and products, demonstration of control measures, pest scouting, loss estimation, pesticide application techniques (dusting, dipping, spraying, fumigation), and others. Irradiation, vapor heat treatment, pheromone repellants, and others, have been included in the latest curriculum. All these are to enable proper identification and diagnosis of pests, diseases, weeds and other related problems, including determination of economy threshold level, and making timely control decisions. They have been assessed and accepted by the University Grants Commission, UNESCO of the UN and other national bodies. To support the courses, textbooks, monographs, pest lists, maps and reference materials are made readily available. Some information is also accessed through the Internet.

Apart from the public sector, a number of pesticide companies and one NGO have conducted training for their staff and farmers. The courses are usually condensed and crop-specific. They include instructions in pest identification, pest scouting, and pesticide use, including safety measures. These courses are also participated by the agriculture extension workers.

The Government of Pakistan has always been keen to improve education in agriculture and plant protection. All efforts are made to assimilate new ideas, systems and materials in the curriculum and to promote innovations in all the subject areas. Topics and reference materials to encourage the use of pesticide products at lower doses, drift-free nozzles, and global positioning system for accurate targeting, are now added to the course work. Contact is also maintained with higher seats of learning at home and abroad to continuously improve the curriculum, and whatever help offered in this regard has always been welcomed.

CURICULUM DEVELOPMENT IN IPM TRAINING

Since the 1960s, emphasis was focused on chemical control. Control measures meant using of pesticides with little attention given to any other measures. This led to the development of insect resistance against many insecticides and heavy expenses in import of pesticides. With the transfer of plant protection from public to private sector in 1980, the use of pesticides gained further momentum and its use increased many folds. National scientists felt a strong need and justification to develop IPM to reduce reliance on pesticides in pest control. In the universities, courses were quickly developed on. Insect Resistance to Pesticides, Male Sterile Technique and Use of Pheromones, and many other areas. Also, institutional capacity building was strongly emphasized. The Government of Pakistan recognized IPM as an essential component in the agricultural production system, hence, IPM was approved and adopted as a national theme and included in the Agricultural Policy, 1991 to promote less reliance on chemical pesticides.

In response, the agricultural education sector developed appropriate curricula for various levels and in different specializations. They aimed to create awareness of IPM, better pest control, safer use of agrochemicals, respect for the environment, and use of alternative low-cost technologies in pest management. The curricula have become a continuous programme for IPM diffusion.

The Provincial Agriculture Departments, Cotton Research Institutes, Rice Research Institutes and Pakistan Agricultural Research Council provided shortduration IPM training to workers, who in turn, impart training to the farmers. IPM workshops in rice, cotton, sugarcane and fruits for researchers, extension workers and progressive farmers were held from time to time. The participants were provided with IPM Field Training Manual, which contained instructions in pest identification, survey and assessment of damage, and appropriate decision making. A Farmers' Field Training Guide was also published in the local language, besides English. The workshops and publications have been helpful in motivating the farming community to adopt IPM within the context of the existing socio-economic conditions in the country. Many private companies also arranged training at the village level. The course/training materials included pest identification, scouting, determining economic threshold levels and harnessing predators and parasitoids. Rice, cotton, sugarcane and apple have received much attention and the curricula contained relevant information in the form of field books with clear illustrations. The course/training itself involved lecture sessions, field trips, observations and evaluation. Each curriculum was prepared in collaboration with world bodies like FAO and the World Bank through collaborators, such as, Winrock International of USA and the Agriculture Research and Extension Departments. All the curricula were crop-specific and updated regularly.

PROSPECTS

The pest management curriculum in Pakistan is dynamic and improvements have been made over time. Its prospects are good in that the courses will be advanced further in the future to enable the students to meet with challenges of pest problems. There have been good interactions with global organizations, research and training centres, and universities, to incorporate new ideas and concepts, methodologies and techniques in pest management into future course work. Sustained efforts are also made to incorporate latest findings in biotechnology, advanced pesticide application technology, post-harvest pest management, research on insect growth regulators, pheromones and other trapping techniques, quarantine procedures, insect resistance management, toxicology and other allied fields, into the curriculum in order to broaden the outlook of the students. However, the design and working of plant protection machinery and field evaluation of pesticides have yet to receive due consideration.

It is generally felt that biotechnology, locust survey and control, and plant quarantine, have been receiving less than the needed attention. Apparently, the existing curriculum is still weak in these important topics. Biotechnology is known to be capable of enhancing further the crop protection measures now in practice. Fungal resistance, viral resistance and herbicide tolerance have been investigated for their effects on productivity and the results have been encouraging. The subject of biotechnology as an aid to plant protection has been proposed at the post-graduate level. This course will comprise of lectures and simple experiments to familiarize the students on the principles, techniques and their applications. On locust survey and control, there is currently no specific curriculum on this subject. This year, in collaboration with the International Pesticide Application Research Center and FAO, a special course will be conducted in August 2000. The curriculum will consist of lectures, demonstrations and practical work by locust experts. Remote sensing, survey methods and control measures will be the main components of the course. The curriculum will also contain topics on alternative control strategies to familiarize the students with swarm tracking and prevention through the use of high performance pesticides, insect growth regulators, pheromones, hormone analogs, entomopathogenic microorganisms and plant components (extracts). For plant quarantine, the agriculture universities and colleges will be asked to offer a course at graduate level to equip students with the knowledge of quarantine pest detection and fumigation. Also of importance is environment safety for which suitable topics have been compiled for dissemination among the students.

PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT IN THE PHILIPPINES

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ABSTRACT

In 1952, the national rat control drive unknowingly started Integrated Pest Management (IPM) in the Philippines using control strategies with a wide range of methods. However, it was only in 1978 that the Philippine Department of Agriculture, through the Bureau of Plant Industry, formally introduced IPM to educate the farmers on the concept and practice of need-based insecticide spraying. Subsequently, recognizing that IPM is information-based and decision-intensive, the IPM programme departed radically from the dominant crop protection approach of calendar spraying. In May 1986, through a presidential pronouncement by then President Corazon C. Aquino, the Philippines adopted IPM as the core of crop protection policy in agriculture. Since then, IPM has evolved into a dynamic, practical and farmer-driven activity, aiming at countering the overuse of chemical insecticides that has resulted in many undesirable problems and causing deep concern over a number of issues relating to ecology, environment and the human health.

The IPM training approaches prior to late 1980s followed the concept of pedagogy, or the art and science of teaching children, using the traditional lecture or didactic approach to learning. However, in 1991, the andragogic approach to IPM extension education was launched in Antique Province through the Antique Integrated Area Development Program with assistance from the FAO Intercountry Programme for Integrated Pest Control in Rice in South and Southeast Asia. The approach, patterned after that of the Indonesian National IPM Programme, was discovery-based, experiential and participatory in nature. It applied the art and science to help adults learn.

On 3 May 1993, former President Fidel V. Ramos launched a revitalized National IPM Programme through Memorandum Order No. 126. Dubbed as *Kasagaanna ng Sakaban At Kalikasan* or KASAKALIKASAN, it is the Philippine government's commitment to Agenda 21 of the *United Nations Conference on Environment and Development* in promoting sustainable agriculture and rural development. The National IPM Programme aims to make IPM the standard approach to crop husbandry and pest management in major areas of rice, corn and vegetables in the Philippines. KASAKALIKASAN, using the andragogic approach, trains farmers and empowers them to become experts in their own fields by developing their ability in making critical and informed decisions, rendering crop production systems more productive, profitable and sustainable.

Today, KASAKALIKASAN takes a new flight as the National IPM Programme expands its reach, sharing its experiences to other field of endeavour. Likewise, the Philippines takes the lead in establishing the ASEAN IPM Knowledge Network as its initiative for regional cooperation in sustainable development. The electronic, Internet-like, and wide-area network seeks to help ASEAN countries improve the effectiveness of IPM implementation by making knowledge sharing easy among national IPM programmes.

INTRODUCTION

KASAKALIKASAN, the local name for the Philippine National Integrated Pest Management (IPM) Program, stands for *Kasaganaan ng Sakahan at Kalikasan*. In was launched by then President Fidel V. Ramos on 3 May 1993 to train farmers in order to empower them to become experts in their own fields by developing their ability to make critical and informed decisions, as well as, to render crop production systems more productive, profitable and sustainable. It aims to make IPM the standard approach to crop husbandry and pest management in rice, corn, and vegetable production in the Philippines.

Through the Farmer Field Schools (FFSs), the programme has been extraordinarily successful in applying an experiential learning approach to enable farmers to practise IPM. Its training strategy involves getting farmers into the field over the entire season to grow a healthy crop. The training process is predicated on farmers' experiences and capabilities to discover and master scientific management skills.

Test results of knowledge, attitude, and practice (KAP) of FFS farmers in rice, corn, and vegetable production showed significantly higher ratings compared to an assigned passing mark. Majority of the FFS farmers applied the IPM principles they have learned in the FFSs, such as, the use of appropriate varieties and the practice of sound cultural management that includes proper land preparation, water and nutrient management, and control of insect pests and weeds. Results indicated that the participatory, experiential, and discovery-based learning technique used by KASAKALIKASAN was effective in enhancing farmers' ecological knowledge and skills in growing healthy crops.

On the whole, KASAKALIKASAN has ushered in a significant shift in the paradigm of agricultural extension in the Philippines. It has significantly reduced the use of insecticides, as shown by the increased number of insecticide non-users and the reduced frequency of insecticide application by users after the FFS. The impact of the FFS can be seen in the shift among farmers from using extremely toxic to least toxic insecticides. Yields in rice, corn and vegetables in almost all the provinces covered by an impact study also exhibited modest to substantial increases and resulted in attractive economic returns. The FFS has put in place a mass of skilled and dedicated farmers, who along with the local governments, are mobilizing local resources and support for IPM programme. Today, KASAKALIKASAN takes a new flight as the Programme shares its experiences and expands its reach to other fields of endeavour.

HISTORY OF PLANT PEST MANAGEMENT CURRICULUM

Before 1970s to Late 1980s

The national rat control drive in 1952 unknowingly started the IPM implementation in the Philippines. Control strategies included a wide range of conventional reductional methods, which include physical, cultural, biological, chemical and legislative control. Following the introduction and increased demand for agro-pesticides after World War II, many issues were raised concerning ecological balance and human health. This was because pesticides misuse have resulted in widespread loss of beneficial and non-target species and increased the buildup of pesticide resistance and incidence of pest resurgence. All these have led to major pest outbreaks in rice and vegetables (Sumangil *et. al*., 1991).

The period of 1970s in Philippine agriculture was identified with the effective control of ricefield rats, brown planthopper resurgence, pesticide resistance and heightened endeavour to establish national self-sufficiency in rice through the Masagana 99 Program. Under the Masagana 99 Rice Production Program (M-99), pesticide provision came along with a package of technology (POT) as a condition to avail production loan. The technoguide 'Sixteen Steps for Masagana 99 Rice Culture' recommended that rice farmers apply pesticides 6–9 times per cropping season as a preventive measure on a calendar basis. However, it was subsequently found that yields were not paying off because of the heavy use of pesticides which was not only unnecessary but also extremely expensive (Callo, Jr., 1990). Moreover, it was even harmful in causing pest outbreaks because the intensive chemical treatments killed natural enemies of pests (Kenmore, *et. al*., 1986).

In 1978, the Philippine Department of Agriculture (DA), through the Bureau of Plant Industry (BPI) formally introduced IPM to educate the farmers on the concept and practice of need-based insecticide spraying. This radically departed from the dominant crop protection method of calendar spraying since the IPM programme was information-based and decision-intensive.

In May 1986, through a presidential pronouncement of then President Corazon C. Aquino, the Philippines adopted IPM as the core of crop protection policy in agriculture. Since then IPM has evolved into a more dynamic, practical and farmer-driven activity.

A low pest profile and absence of contemporary pest outbreaks characterized the 1980s. It was during this period when separate IPM technologies for black bug and the golden apple snail were developed. Additional technologies on economic threshold levels (ETLs), pest monitoring, judicious use of pesticides and enhancement of endemic beneficial insects have helped to adjust the earlier national IPM recommendations. To best mobilize all Philippine resources to achieve the goals of the IPM programme through strengthening and applying community-based knowledge, strong collaborative efforts by both the government and private sectors in research, training and extension at the regional level (moving quickly to the local levels subsequently) was necessary. In the training component, the training needs of the different target groups were found to differ. The target groups included subject matter specialists (SMS), municipal experts and village extension trainers (pesticide dealers, field agents, and paramedics), plantation workers and the farmers. Thus, development of the various training curricula need to consider the following (Callo, Jr., 1990):

- Types of training courses. During this period, the IPM training courses were of four types. These were: (i) Specialized Training Courses for National Trainers (NTs), Research and Extension Specialists (RES); (ii) SMS Training Course; (iii) Training Courses for Municipal Experts and Village Extension Trainers (MEVET); and (iv) Training Courses for Farmers and Farmer-Leaders (FFL).
- Training content and plans. The subject matter content and training plans were prepared based on the results of baseline surveys which assessed the actual local problems and priorities. Regardless of the type of training course, the activities consisted of 60% fieldwork, 15% laboratory work, 20% classroom work and 5% self-study. The specialized training course had a duration of four weeks or approximately 200 contact-hours; SMS training course had time frames of 12–14 days or 72–96 contact-hours; MEVET training course usually lasted for 5–7 days or 42–50 contact-hours; and farmers' training course had a duration of 3–5 days or 30–35 contact-hours.
- Selection of training participants. In the case of participants in training of farmers, the selection started with farmer-leaders, opinion leaders within farmers' associations and out-of-school youths. These people were perceived as more effective agents of change than were the other members in the community. On the other hand, only full-time

extension agents who have shown interest and commitments in the IPM programme were selected as participants in MEVET training course. In practice, only participants who excelled in MEVET training course were selected to undergo the SMS training. Participants who excelled in SMS training were then selected to undergo NTS or RES training.

- Training methodologies. Regardless of the type of training course conducted, direct teaching and extension methods were employed. The former involved demonstration, practice, test, monitoring and impact evaluation. The extension methods made use of: (a) field walks to trouble shoot pest problems, (b) labelling results of demonstrations, (c) field and home follow-ups, and (d) informal group discussions. For NTS, RES, SMS and MEVET training courses, additional extension methods were used, namely: (a) practice teaching, (b) establishing action research and results from demonstrations, (c) conducting baseline surveys, and (d) conducting training classes for agricultural production technicians (APTs) and for farmers. The activities illustrating each training methodology are summarized in Table 1.
- Motivational procedure. Regardless of the type of training course conducted, the participants were motivated in IPM technology through scaring sessions and lecture-discussion on the profitability of IPM technology. Scaring sessions usually included topics, such as: (a) fear arousal in pesticide usage and (b) locally available alternatives for pesticides. On the other hand, the profitability and other benefits of the IPM technology were discussed by comparing yields and profits, including the incentives when the IPM technology was employed.

Table 1. Training methodologies and activities under each type of IPM training course, Philippines 1990.

TRAINING METHODOLOGY/ACTIVITY	**TYPE OF TRAINING COURSE**			
	FARMER	**MEVET**	**SMS**	**NTS/RES**
Teaching Methods:	X	X	X	X
	X	X	X	X
• Demonstration	X	X	X	X
• Practice	X	X	X	X
• Test	X	X	X	X
• Monitoring	X	X	X	X
• Impact Evaluation	X	X	X	X
	X	X	X	X
Extension Methods:	X	X	X	X
	X	X	X	X
• Field walks for trouble-shooting	X	X	X	X
• Labeled result demonstration	X	X	X	X
• Field and home follow-up	X	X	X	X
• Informal group discussion	X	X	X	X
• Practice teaching	0	X	X	0
• Establishing result demonstration (Eco-demo plots)	0	X	X	X
• Establishing action research trials	0	0	X	X
• Conducting baseline survey	0	0	X	X
• Conducting actual farmers' class	0	X	0	0
• Conducting actual APT class	0	0	X	X

X = Activities or methods used in a training course
0 = Activities or methods not included in a training course

- Skills evaluation techniques. Regardless of the type of training course conducted, the skills developed by the participants were evaluated by a combination of the following techniques: (a) ‘Ballot Box’ evaluation, (b) ‘Snap-Shot’ evaluation, and (iii) ‘Plant-By-Plant’ assessment. The ‘Ballot Box’ was a practical tool for evaluating field problems and for assessing skill in identifying pests and natural enemies. It was usually employed at the beginning of a course (pre-test), in the middle (mid-term) and at the end of the course (post-test). The ‘Snap-Shot’ technique was a rapid decision-making tool to establish whether the pest conditions in the field was above, within or below the action levels. In the training, every participant had to develop his/her own ETLs for various pests. On the other hand, the ‘Plant-By-Plant’ assessment was a rapid decision-making tool that was particularly effective for assessing damage caused by insect pests.

Early 1990s Torrent

Since 1991, a pilot IPM project in Antique, Central Philippines, has been extraordinarily successful in applying an experiential approach which enabled farmers to use IPM in growing rice and other associated food crops. The project was carried out with technical assistance and supplemental funding from the FAO Intercountry Programme for Integrated Pest Control in Rice in South and Southeast Asia (Medina and Callo, Jr., 1999). This was patterned after the training strategy that was developed by the Indonesian National IPM Programme. It involved getting trainers and farmers into the actual crop for an entire season to learn and grow the crop by practical experience. The training contents were predicated on the assumption that farmers needed a better understanding of the factors affecting crop growth as part of the crop-field agroecosystem. Farmers, through the field training, became equipped to make their own assessments of the balance between pests and their natural enemies in their own fields; hence they were able to make the rational decisions on how to manage their crops.

On 3 May 1993, the former President Fidel V. Ramos launched a revitalized National IPM Programme through Memorandum Order No. 126. Dubbed as *Kasaganaan ng Sakahan At Kalikasan* or KASAKALIKASAN, it is the Philippine government's commitment to Agenda 21 of the *United Nations Conference on Environment and Development* in promoting sustainable agriculture and rural development. The programme aims to make IPM the standard approach to crop husbandry and pest management in major rice, corn and vegetable areas in the Philippines (Binamira, 1999). Specifically, the programme's objectives are to:

- Enhance a farmer's knowledge and skills in using IPM in crop production through field-based experiential learning activities, field-testing of IPM technologies in agricultural crops and incorporating them into training activities;
- Establish firmly the continuation of non-formal education (NFE) in crop protection for farmers at the provincial up to the municipal level; and
- Put in place the policy and legislative framework that will facilitate the long-term success of the programme activities.

KASAKALIKASAN trains farmers and empowers them to become experts in their own fields by developing their ability in making critical and informed decisions, including making crop production systems more productive, profitable and sustainable. The training approach is essentially andragogic. Hence, it is experiential, discovery-based, group-oriented, involves critical thinking and adopts a horizontal relationship among learners and trainers. Its learning process revolves around the following basic practices:

- Growing a healthy crop by using resistant varieties, better seed selection process and efficient nutrient, water and cultural management;
- Conserving beneficial insects like predators and parasitoids; and

- Observing fields weekly to determine management actions necessary to produce a profitable crop.

The above practices do not disrupt the agroecosystem, allowing natural pest control to take place. They also minimize pesticide usage such that it is economical and is relatively safer for humans and the environment.

The training process is based on farmers' experience and their capabilities to discover and master scientific crop management skills. Evaluations have shown that farmers involved in the pilot project used significantly less pesticide, obtained equal or better crop yields and earned higher incomes from their crops. Of even greater significance in the long term was the awakening of farmers' interest in crop ecology. This enabled them to quickly adapt into their local conditions any new agricultural innovations that they perceived to be beneficial (Philippine National IPM Programme, 1993).

- **Types of training activities**. Under KASAKALIKASAN, the current Philippine National IPM Programme supports four distinct training activities to institutionalize this new IPM training philosophy at the local levels. These training activities are:
    a. *Training of Trainers (TOT) for field workers as IPM trainers*. A cadre of selected field workers from local government units (LGUs) and non-government organizations (NGOs), including farmer-leaders, in the targeted provinces are given intensive training (three days a week) over a season-long TOTs of 4–5 months. Upon graduation, these trained field workers are relocated on a full time basis to train farmers in FFSs in their respective communities or villages.
    b. *Training of Specialists (TOS) for IPM specialists*. Selected IPM trainers undergo an intensive season-long TOSs (4–5 months; six days a week). Upon graduation, they are deployed as IPM Field Officers, who in turn are responsible in conducting TOTs in their respective provinces. The Philippine Rice Research Institute (PhilRice), the University of Southern Mindanao (USM) and Benguet State University (BSU) are the lead agencies in the TOSs for rice, corn and vegetables, respectively.
    c. *Farmer Field School for farmers' training by IPM trainers*. In an FFS, farmers meet in a 'learning field' (of at least 1,000 sq m) for half-day a week in a season-long training of 4–5 months. IPM Training Teams, composed of two trainers in conjunction with at least two extension workers, undertake four FFSs every cropping season. Each FFS consists of 25–30 farmers. In addition to training at FFSs, these teams, in partnership with LGU extension workers, will make regular follow-up activities of FFS farmer-graduates, particularly on the farmers' field investigations and to update them on new IPM and related technologies and to foster group cohesion and farmer empowerment.
    d. *Training of Farmer Trainers (TFT) for farmer-to-farmer training*. After an FFS, volunteer farmer-graduates are trained as IPM farmer-facilitators to undertake FFSs among fellow farmers.

- **Characteristics of the approach**. A season-long IPM training brings farmers and trainers together to carry out an intensive training on IPM methods and issues over the life cycle of the crop. The FFS trains farmers to become IPM experts in their own fields. An FFS is located in the area where the IPM trainer normally works. In teams of two, the IPM trainers manage two farmers' groups with the assistance of two extension workers already working in the area or village on a long-term basis. Each FFS meets for half-day each week over the duration of the crop production season. The IPM Training Team meets once a week to plan the following week's FFS activities. Before the FFS begins, extension workers in the area should have already received one week of FFS orientation. The orientation focuses on IPM principles and methods, as well as the roles of IPM trainers and extension workers in conducting the FFS. During the orientation, the extension workers assist the trainers in planning two FFSs and in developing the FFS follow-up plans in the extension workers' areas. The principles that guide an FFS learning process are:

a. *The field is the primary learning resource*. All learning activities take place in the field or are based on what is happening in the field. The field becomes the main reference, the primary learning materials and the focus of learning.
b. *Experience form the basis of learning*. All learning is based on the farmers' experience in the field. The activities that take place in the field form the basis for discussion and analysis by farmers who arrive at concepts which they test and improve through further field activities.
c. *Decision-making guides the process*. Training is focused on the agroecosystem analysis (AESA) of the crop. This analysis helps farmers gain insights into the ecological interactions in the field. The combination of analytical methods, ecological insights and basic IPM principles, such as growing a healthy crop, provides farmers with a wide knowledge base that helps them gain confidence in their decision-making skills.
d. *Training lasts the entire growing season of the crop*. Each FFS lasts the entire growing season of the crop. Farmers acquire a firm understanding of the relevant IPM concepts for each stage of the crop growth; from planting to harvest. Thus, farmers learn the factors that influence decision-making in pest control at all stages of the plant growth.
e. *Curriculum development is well-coordinated with the local field conditions*. The FFS curriculum is based on the materials used for the TOT. The materials selected are based on appropriateness to the FFS, local conditions of the FFS, and the problems and needs of the farmers participating in the FFS.

- **The FFS curriculum**. FFSs are based upon a solid, field-tested curriculum and material package that cover an entire crop production season and directly incorporate key IPM principles. The IPM trainer has experienced and practised all the activities used in the FFS during his/her own intensive season-long IPM training. The materials used for IPM training, namely ‘Field Guide of Discovery-Based Exercises for (Rice, Corn or Vegetables) IPM’, ‘Handbook of Non-Formal Education and Team Building Exercises for Integrated Pest Management’ and ‘KASAKALIKASAN, The National IPM Program Document’, provide the basis for the FFS curriculum. These materials are used based on their appropriateness to the FFS conditions. A typical day for an FFS is divided into three parts as shown in Table 2.

During the 14–16 weeks, which typically cover the crop season, farmers in an FFS will have the opportunity to observe a crop in every stage of its growth and development. Field monitoring activities in small groups will result in an agroecosystem drawing that is used for analysis. This is related to plant growth, agronomy, crop-field ecological issues (e.g., effects of soil fertility, water, weeds, etc.) and decision-making questions that would serve as discussion guide. These are treated in both small and big group discussions.

The small group discussions get farmers to talk about their ideas on what is happening in the field and why these things are happening. The training team circulates among the groups and helps them to examine their ideas by posing problems and various scenarios. The large group discussion is the time when small groups can present their ideas to the full group. During discussion time, the trainers help farmers clarify their thinking by posing ‘what if’ scenarios. The trainers also use this time to present any additional information related to plant growth and ecosystem issues that have been missed out in the discussions.

Table 2. Typical schedule for any given day of a farmer field school on integrated pest management, Philippines 2000.

TIME	ACTIVITY/TOPIC
07:00–08:00	• Field Monitoring in Small Groups
08:00–09:00	• Agroecosystem Analysis (AESA) and Discussions in Small Groups
09:00–10:00	• Large Group Discussions
10:00–10:15	• BREAK
10:15–10-45	• Group Dynamics Activities in Large or Small Groups
10:45–11:45	• Special Topics Activities in Large or Small Groups
11:45–12:00	• Evaluation of the Week's Activities and Planning for Next Week's Activities

Group dynamics activities are included in the FFS. These activities help to develop the participants into a closely-knit IPM team. They establish a learning climate that is enjoyable and less formal. They also help participants to experience and identify various aspects of team work, such as mutual support, importance of individual role to the team's success and the behaviours that can build or hinder team work. Likewise, they may help the participants experience what can be accomplished by working together.

The special topic sessions might concern particular issues such as rat damage or they may be involved in a field study being carried out in the FFS learning field. These special topics usually vary from FFS to FFS and reflect the individual FFS needs. Some of the topics are planned in advance of the FFS while others are developed as the FFS progresses. A schedule for special topics in a season-long FFS might look like those shown in Table 3.

Table 3. Sample schedule for special topics in a season-long farmer field school on integrated pest management, Philippines 2000.

WEEK	SPECIAL TOPIC
1st Week	• Pre-test • What is this? (Functional roles in the ecosystems)
2nd Week	• Integrated Soil Management
3rd Week	• Parasitoids and Chemical Pesticides
4th Week	• Predators and Insect Zoos
5th Week	• Insect Pathogens and Biological Pesticides
6th Week	• Life Cycles and Food Webs • Rodent Population Dynamics
7th Week	• Organizing Community-based Rodent Management Strategies
8th Week	• Designing an IPM Decision-making Tool
9th Week	• Pest Resurgence and Pesticide Resistance
10th Week	• Weeds and Weed Management
11th Week	• Diseases and Disease Culture
12th Week	• Folk Media and Field Day
13th Week	• Varieties and Seed Production
14th Week	• Harvest and Post-Harvest Management
15th Week	• Marketing and Cost-Return Analysis
16th Week	• Post-Test

- **Selecting the FFS site**. The IPM trainers make a map of the area in which they plan to work. On this map, they identify where their office will be situated, outline the extension areas for which they are responsible, and identify the extension worker(s) responsible for each aspect of work. Each of these extension areas is then evaluated on the basis of a set of criteria. These include: (i) extent of intensively cropped fields within an extension area, (ii) accessibility of the area from the trainers' and extension workers' rural extension center, (iii) sufficient number of participating farmers, including the presence of active farmers' groups in the extension area, and (iv) competency of the extension workers assigned in the area. Extension workers, working with the IPM trainers, are to help determine which farmers' groups will be the sites for FFS. They also help to develop a curriculum and plan for FFS activities based on the local conditions and issues.
- **Selecting the participants.** Each extension worker works with 5–10 farmers' groups. The extension worker selects two farmers' groups from his or her extension area and the participants for the FFS are selected from these groups. The farmers' groups are generally selected on the basis of the extension workers' knowledge of the group, how active the group is, and the advice of local government officials. Participation of local government officials in the selection of the farmers' group is important. They are first briefed on the goals of IPM and the FFS. Their support of the FFS will help eliminate any misunderstanding at the local level.
  The IPM Training Team then meets with the leaders of the selected farmers' groups to brief them on the purposes of IPM and the goals of the FFS. Final selection of the participants is carried out with their help. Only 25–30 farmers may participate in the FFS. The following criteria are crucial for selection of FFS participants:
  a. *The participant must be an active farmer*. This means that the participant has access to land which he or she actively farms. Of lesser importance is the extent of the land being farmed or whether the land is actually owned by the participant;
  b. *The participant must be able to attend all of the FFS sessions*. The participant must have the time to attend every session as each session builds on earlier sessions and on the growth of the crop; and
  c. *The participant must be willing and able to act as informant about IPM for the rest of the members in his or her farmers' group*. Implied in this criterion is the ability and willingness of the farmer to communicate with others and his/her willingness to accept the responsibility of helping his or her neighbours.

THE REFORM OF CURRICULUM
Pedagogical (Before 1970s to Late 1980s)

Essentially, the IPM training approaches or methodologies used before 1970s to late 1980s were pedagogical in nature. These approaches and methodologies approximated the concept of pedagogy, which means the art and science of teaching children to learn (Medina and Callo, Jr., 1999). It used the traditional lecture or didactic approach to learning.

Attitudinal relationships in this approach were nearly always on the parent-child, teacher-pupil, professor-student, or guru-disciple level. The teacher or trainer was an authority figure; he/she was the centre and the star in the learning process. It meant drawing conclusions from accepted or already known principles, concepts, generalizations, as well as theories, and to infer from them so as to expand the principles further. The main objective of learning was to increase or change the factual knowledge, with the hope that the latter will be applied to life. Training approaches and methodologies during this period conformed very well with the obsolete Training and Visit (T&V) extension system espoused by the academe, particularly the National Crop Protection Center (NCPC) of the University of the Philippines in Los Baños (UPLB) between 1970s and 1980s. This was the chief extension strategy of the Philippine Masagana 99 Rice Production Program in the early 1970s.

Masagana 99, the green revolution for rice and the apparent forerunner of IPM in rice in the Philippines, advocated the use of short, early maturing, high yielding pest resistant varieties to complement pest-suppressing cultural and physical practices. The strategy also demanded an increase in use of fertilizers and pesticides; the latter as preventive measure by calendar applications that have resulted in more pest outbreaks and higher crop loss ultimately. The inadequacy of the T&V method in IPM extension work highlighted the need for a more comprehensive extension approach that would permit proper use of pesticides and adaptation of improved crop protection technologies (Sumangil, *et. al*., 1991).

Introducing farmers to IPM practices has proved to be difficult. Conventional extension methods that were classroom-based could not be adapted to the local conditions, allowing only one-way flow of information from extension agents to the farmers. The latter received the same pre-determined advice regardless of the diversity of the agroecological environment and the pest problems.

Andragogical (Early 1990s to the present)

In contrast, the IPM training approaches or methodologies used in the late 1990s are andragogical in nature. These approaches and methodologies approximate the concept of andragogy, which means the art and science of helping adults learn (Medina and Callo, Jr., 1999).

In the learning process, a set of individual cases or circumstances is presented for study. From their own empirical observations, participants formulate concepts, establish general principles, and perhaps evolve theories that will provide greater clarity to the understanding of these cases or circumstances. The learning process is evocative, dialogic, participatory and experiential.

The andragogic approach to IPM extension education that was successfully piloted in 1991 was essentially discovery-based, experiential and participatory in nature and has the following features:

- The learning process was aimed at building farmers' capabilities in internalizing crop management skills through discovery and experience;
- Trainers, acted more as facilitators, and farmers were considered partners, hence nobody dominated the learning process;
- Trainers and farmers learned together by practical experience in the field in one whole cropping season;
- Learning was founded on the concrete analysis of the crop-field agroecosystem; and
- Farmers, who were facilitated by trainers, made their own assessments on the balance between pests and the beneficial organisms.

Andragogy as a learning strategy uses mostly NFE methods and approaches. NFE methods and approaches, as knowledge management strategies, bring about sharing of knowledge and the creation of new knowledge, and in the process empowers the participants. Activities focus on allowing participants to observe, discuss, interact, brainstorm, as well as perform analysis, including making critical decisions and solve problems (Callo, Jr., *et. al*., 1999).

Essentially, NFE is a participatory educational process based on the assumptions that the adult learners can contribute to the learning process. When adult learners decide to participate in any learning activity, they bring along a wealth of experience, knowledge and skills. They are armed with their own beliefs, values, and convictions. They have their own perceptions, biases and feelings. With such a background, the adult learner is the richest resource in the learning process (Ortigas, 1997).

NFE methods and approaches encourage participants to see themselves as an important source of information and knowledge about the real world. When they are encouraged to work with the knowledge they have gained from their own experiences, they can develop strategies together to change their immediate situations. Such learning experiences may take place in several ways as described below (Society for Participatory Research in Asia, 1987):

- *Existing popular knowledge is recognized and valued*. The learning process starts with the assumption that participants already possess some knowledge. Participants do not start with a clean slate. In this approach, the synthesis of popular knowledge with existing scientific knowledge strengthens the learning experience of the participants.
- *New knowledge is built on the existing knowledge*. In the learning process, the starting point for creating new knowledge is the existing knowledge that people already have, in particular the fundamental elements. As people begin to appreciate what they already know, they are more open to seek new information. This desire to seek new information and knowledge enhances the learning process.
- *Participants learn to exercise control*. The learning process puts emphasis on the active participation of participants in generating their own knowledge. This encourages them to take the responsibility for their own learning. It is this active posture which constitutes a powerful impetus for learning and for learners to exercise control over their learning.
- *Learning becomes a collective process*. One of the elements of NFE is the promotion of collective responsibility for seeking new knowledge. As a result, participants learn to get together, collectively seeking and analyzing information.
- *Learning creates informed options*. The very process of collectively analyzing a given situation throws up various alternatives. As part of the process of analysis, options are debated on the basis of concrete information. As a result, participants are able to accept and reject options on an informed basis. This creates a sense of empowerment, which is based on the confidence that the information has been understood and interpreted.
- *Actions emerge out of this analysis*. The very act of involvement in the process of analyzing a given reality creates a sense of ownership of that knowledge and a willingness to transform that situation. The participants are then able to take concrete actions.

Guided by the above, where possible, facilitators should create a learning situation where adults can discover answers and solutions for themselves. People remember the things they have said themselves best, so facilitators should not speak too much. They need to give participants a chance to find solutions before adding important points that the group has not mentioned (Hope and Timmel, 1994).

The institutionalization of andragogy as a learning approach in Philippine agricultural extension is one of IPM's lasting legacies. In every assessment of the Philippine National IPM Programme, the very high degree of success attained by the programme activities was attributed to the participatory, experiential and discovery-based learning approaches in the FFS.

CURRICULUM DEVELOPMENT IN AGRICULTURAL UNIVERSITIES AND RELATED INSTITUTES OF THE PHILIPPINES

The National Crop Protection Center of the University of the Philippines at Los Baños

The NCPC of UPLB was created under Presidential Decree (PD) No. 936 issued on 21 May 1976 in response to the need of the country to have a unified approach to research, training and extension programme in crop production (Davide, 1990). However, at the conception of NCPC, the T&V extension system was the main extension strategy in agricultural development, such as the Masagana 99 Rice Production Programme and Masagana Corn Production Program, which included crop protection as an important programme component. At that time, agricultural extension was also a function of the DA and the academe, including the UPLB.

During this period, DA was dependent on the academe for development, packaging, and to some extent, even in the implementation of crop protection programmes of the government. For this reason, curriculum development in crop protection was more often patterned after the pedagogical learning methods, which the academe were more familiar with. Thus, even the mandate of NCPC were developed to reflect the traditional didactic approach to crop protection, such as:

- To undertake problem analysis, developmental research and planning required to develop crop protection systems against pests of major economic crops;
- To develop and implement manpower training programmes designed to upgrade the pool of manpower required to meet the complex pest control needs of the country;
- To undertake information exchange and extension to provide farmers and the public with coordinated information about the varied facets of pest control and to emphasize the urgent need for safe and effective pest control practices;
- To establish adequate linkages between research and operational phases at the farm level in order to ensure that the changing research needs of operational activities are met and that operational activities are based on the most recent and applicable findings; and
- To provide scientific advice to government planners for the formulation of policies and regulatory programmes necessary for dealing with the complex pest control technologies essential for the protection of crops.

In the 1980s, however, a series of reorganization took place in the Philippine agricultural extension system. Firstly, the once centralized DA was decentralized, moving many research, training and extension functions from the central to the DA regional offices. Secondly, commodity agencies were created to do research, training and extension functions for various commodities. These included the Philippine Coconut Authority, Philippine Cotton Research and Development Institute, Philippine Tobacco Research and Training Institute, Fiber Industry and development Authority, Sugar Regulatory Administration, and Philippine Rice Research Institute, among others. Thirdly, a new Local Government Code was passed into law devolving the extension function of the DA to the LGUs and NGOs.

The Bureau of Plant Industry's Crop Protection Division and Regional Crop Protection Center of the Philippine Department of Agriculture.

With the abolition of the Philippine Bureau of Agriculture and the birth of the BPI in 1930, Crop Protection Division (CPD) underwent a series of reorganization (Panganiban, 1981). Under the same PD 936, which created NCPC in 1976, the CPD Chief became its ex-officio Deputy Director. One of the functions of the CPD was to provide technical assistance, coordination, and where necessary, supervision over regional facilities of the Regional Crop Protection Centers (RCPCs) and the Surveillance and Early Warning Systems (SEWS). It also included curriculum development in crop protection for the local communities in close collaboration with the RCPCs and LGUs.

In 1986, when IPM was proclaimed as the core crop protection policy in Philippine agriculture, CPD assumed a more important role in enhancing local implementation of applied research, training and extension programmes in crop protection. During this period, although the training approach was less participatory and experiential, many field-based activities were already conducted using hands-on and demonstration methods, which more or less approximated the current discovery-based approach of the FFSs.

Progressing from the failure of the traditional T & V extension system to that in which complex IPM messages were delivered effectively to farmers was truly a period of reckoning. It was also the transition period between the KAP approach and the current participatory, experiential and discovery approaches of the FFS that was espoused by the FAO Intercountry Programme for Integrated Pest Control (IPC) in Rice in South and Southeast Asia. However, compared to the T & V extension approach, the KAP approach was a more revolutionary way in developing farmers' skills. The latter approach, for instance, has enabled farmers (mostly under paddy conditions) to achieve in 3–5 days the capacity to separate out natural enemies from the key rice pests, understand and use action thresholds, and to apply insecticides judiciously (Bautista and Sumangil, 1987).

CURRICULUM DEVELOPMENT OF IPM TRAININGS
Use of Non-Formal Education or Farmer Field School Approach

Paticipatory and cooperative approach

The concept of FFS is centred on farmer participation and empowerment. It is concerned with improving decision-making skills and stimulating organized action. Through empowerment, “farmers learn to stand on their own and think for themselves … farmers learn to do their own field observations, make their own discoveries, make their own decisions, and take action on their own” (FAO, 1997). Hence, the core of the IPM learning process is made up of farmers engaged in self-discovery, finding solutions to technical and social aspects of crop production.

From a philosophical perspective, participation makes IPM farmers see themselves as unique individuals, and at the same time, active members of the farm community. Accepting participation as a basic human need implies that participation is a human right, and that it should be accepted and fostered for itself alone and for its results. Farmer participation is not simply a fringe benefit that authorities may grant as a concession, but a human being's birthright that no authority can deny him of. The institutionalization of farmers' participation in agricultural development requires a change in mindset. This is quite possible if the basic paradigms on which agricultural institutions are currently built undergo significant change. Since the Philippine National IPM Program concept is participative and empowering, it also calls for a programme approach that is participative, collaborative, flexible, and network-based (Medina and Callo, Jr., 1999).

Discovery-based methods

Essentially, the heart of the Philippine National IPM Programme is the FFS. An FFS is a ‘school without walls’, bringing farmers together to undergo an intensive training on IPM over the entire life cycle of the crop. Thus, FFS farmer-participants meet for 14–16 weeks (a whole cropping season), from land preparation to harvest. Each FFS has at least 1,000 sq m to 2 ha ‘learning field'. Each week, farmers practise AESA in the 'learning field' which includes plant health, water management, weather, nutrient management, weed density, disease surveillance, as well as, observation and collection of insect pests, beneficial predators, and parasitoids. Through direct experience and critical analysis, farmers interpret their observations in the AESA to make field management decisions. An FFS therefore trains farmers to become experts in their own fields.

Experiential learning approach

In small group discussions, farmers share their ideas on what have been happening in the field and why these things are happening. Facilitators circulate among the group and help farmers analyze their observations by posing problems and create different scenarios. In the large group discussions, the small groups share their ideas with the whole FFS group. Facilitators help participants in the discussion, posing 'what if' scenarios. They also share additional information related to plant growth and ecosystem not covered by the group discussions.

Capacity and Capability Building for Implementation of Local IPM Programmes

Building field extension confidence through competence

KASAKALIKASAN trains a cadre of extension workers from the LGUs and NGOs, including farmer-trainers, in season-long IPM TOTs. The TOT course requires trainee-participants to grow several fields of rice, corn or vegetable crops, and perform all the tasks, including land preparation, planting, weeding, fertilizing, managing pests and harvesting the crop. The trainee-participants conduct specific field studies addressing local field problems and share discovery activities that illustrate basic IPM principles. Trainees learn about experimental methods, statistics, economic analysis, and ecosystem analysis, so that they can better assist farmer groups in implementing local field studies.

Group dynamics emphasizing horizontal communication and group cooperation are also part of the core of TOT curriculum. Trainees test their facilitating skills in FFSs, which are conducted as integral part of the TOT. They guide farmers in making observations and analyses, and in conducting comparative IPM plots and other IPM study activities.

Through hands-on training, extension workers become competent 'farmers' with better agronomic and analytical skills, building within a sense of self-confidence and respect for farmers as partners in development.

Strengthening farmer organizations

The National IPM Program is revitalising farmer organizations and farming communities by organizing and conducting IPM FFSs. Discovery-based learning techniques, experiential learning methods and cooperative approaches bring about creation of new knowledge, the sharing of knowledge and empowerment of farmers. The FFSs provide the farmers' first experience with experimentation based on ecological principles, participatory training and NFE methods. Once the foundation is laid, farmers are better able to act on their own initiatives and to sharpen their observations, research and communicative skills.

Reshaping public opinion through programme advocacy

The National IPM Program takes a proactive stance in reshaping public opinion on pesticides by providing field orientation and information to national and local government officials and policy makers, journalists, NGOs and consumer groups.
At the village (barangay) level, farmers promote IPM through 'horizontal communication' activities. These include field days, folk media presentations, IPM fairs and exhibits, farmer-government dialogues and IPM farmer congresses.

PROSPECTS
Community-based IPM Programmes

Today, KASAKALIKASAN takes a new flight as the Program expands its reach, sharing its experiences to other fields of endeavour (Binamira, 1999). In response to the demands of the Program's stakeholders, KASAKALIKASAN carries out the following developmental activities:

- Building management expertise of LGUs on IPM for secondary and migrant pests, especially, the Malayan rice black bug, locusts, golden apple snail and rats.
- The expansion of the farmer-managed participatory technology development (PTD) activities through the BPI.
- The conduct of pilot FFFSs on backyard livestock production with the Bureau of Animal Industry.
- The conduct of FFSs on child nutrition and maternal care with the National Nutrition Council.
- The expansion of the IPM farmer-to-farmer extension approach within agrarian reform centers with the Department of Agrarian Reform.
- The conduct of pilot FFSs on social reforestation with the Department of Environment and Natural Resources.
- A joint participatory and community-based health monitoring programme involving agricultural high school students with the Department of Education, Culture and Sports, and the Department of Health.

International Collaboration and Knowledge Networking

KASAKALIKASAN has learned a great deal from other countries in the ASEAN region. Its training methodologies were first used in Indonesia through the FAO Intercountry Programme for IPC in Rice in South and Southeast Asia. Field studies have been adapted from research activities undertaken at various international research organizations, such as, the International Rice Research Institute (IRRI) and the CABI International Institute of Biological Control (CABI-IIBC). Collaboration continues, as experiences and new approaches developed in the Philippines are now being shared with other national programmes.

The Philippine model, with its strong policy support, commitment of resources, emphasis on human resource development, ecological perspective and participatory training methodologies, is being closely watched by other countries. Policy makers and field training teams from more than forty countries have visited the Philippines to learn what can be adapted from KASAKALIKASAN.

KASAKALIKASAN continues to maintain its strong linkages with the FAO Programme for Community IPM in Asia through the implementation of community-based IPM activities as follow-up to FFSs. Building from its collaboration with the FAO Farmer-centered Agricultural

Resources Management Program, the Programme continues to support integrated soil management (ISM) initiatives under the FAO Special Programme for Food Security.

The Programme has built and expanded its cadre of IPM trainers, providing technical assistance in the conduct of IPM training activities in Asia (*viz:* Bangladesh, Cambodia, India, Loa PDR, Sri Lanka and Thailand) and in Africa (*viz:* Ghana and Kenya).

Today, the Philippines takes the lead in establishing the ASEAN IPM Knowledge Network as its initiative for regional cooperation in sustainable development. The electronic, Internet-like, and wide-area network seeks to help ASEAN countries improve the effectiveness of programme implementation by making knowledge sharing easy among national IPM programmes.

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PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT IN THAILAND

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ABSTRACT

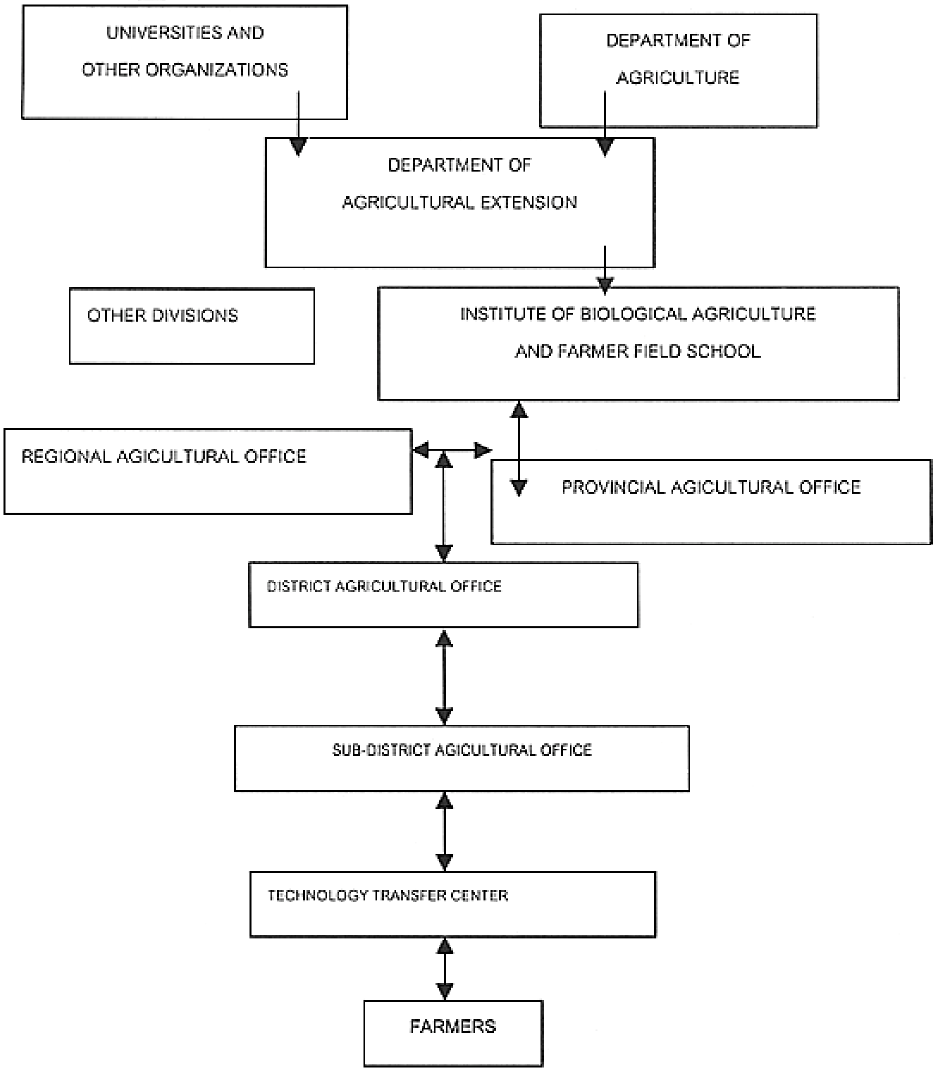
The concept of Integrated Pest Management (IPM) in Thailand has been established prior to 1975, mainly to cope with pest problems, intensive use of pesticides and environmental concerns. Manuals for rice, vegetables, soybean, mung bean and cotton have been produced to train extension workers in IPM concepts, pests and their natural enemies, economic threshold analysis and control measures. In 1992, a curriculum for season-long training in rice was first drafted, but it was not widely used in the extension system. In 1994, the Integrated Pest Management in Selected Fruit Trees Project introduced "The IPM Extension Programme" and produced the curricula for durian and mango. These were for extension workers to use as guides in their work with fruit growers. However, in 1998, a more recent approach to IPM in rice and vegetables was developed under the Royal Initiative. It introduced a training process focusing on human resource development and using the experiential learning and empowerment approach. The curricula for trainers and for farmers are being developed for use in Training-of-Trainers courses and in Farmer Field Schools.

INTRODUCTION

Around 1969, during the period of "Green Revolution", the Thai Government's policy on agriculture was to increase crop production, which also led to the increasing use of fertilizers and pesticides. Thus, the concept of Integrated Pest Management (IPM) was established even prior to 1975, mainly to cope with pest problems, intensive use of pesticides and related environmental concerns. The early IPM strategies focused mainly on field scouting, pest forecasting and spraying decisions based on economic threshold analysis of the major pests. Most of the research was oriented towards the development of spraying thresholds and on integrating other control tactics.

From the 1980s onward, the design for IPM focused on on-farm trials and the strategy to transfer useful concept and technologies (Figure 1). The use of economic threshold analysis to assist decision on chemical control has been shown to be profitable when compared to calendar pesticide application. However, this approach with threshold analysis did not work well with farmers due to its complexity. Moreover, most farmers, as well as the extension workers, have long been accustomed to using pesticides on a prophylactic basis and so found it difficult to adopt the threshold analysis concept. Thus, for effective IPM transfer, it was evident that there must be intensive and adequate training for both the extension agents and the farmers.

Figure 1: Technology Transfer in Extension System



CURRICULUM DEVELOPMENT IN AGRICULTURAL EXTENSION

CURRICULUM DEVELOPMENT IN AGRICULTURAL EXTENSION

In 1981, pest management in rice was carried out largely through the Surveillance and Early Warning System (SEWS). After modification in 1984, this system was practised nationwide. The manual for the SEWS training course was produced to train Plant Protection Specialists in IPM concepts, pest and natural enemy identification, economic threshold analysis and the relevant control measures. Farmers were also trained to sample their fields using standard procedures. This concept was applied also to other crops, such as, vegetables, soybean, mung bean and cotton. The manuals were produced to serve as guidebooks for extension workers to transfer the pest management technologies to farmers. In 1990, the methods for implementing IPM in rice were modified through the technical assistance of the Food and Agriculture Organization of the United Nations (FAO). It was carried out under the FAO Inter-Country Programme for Integrated Pest Control in Rice in South and Southeast Asia. A Working Group for launching the IPM strategy was established and curriculum development workshops were held. In 1992, the first rice IPM curriculum for farmers was developed and used by the extension workers. The contents of the curriculum, which was designed for season-long training, included activities for

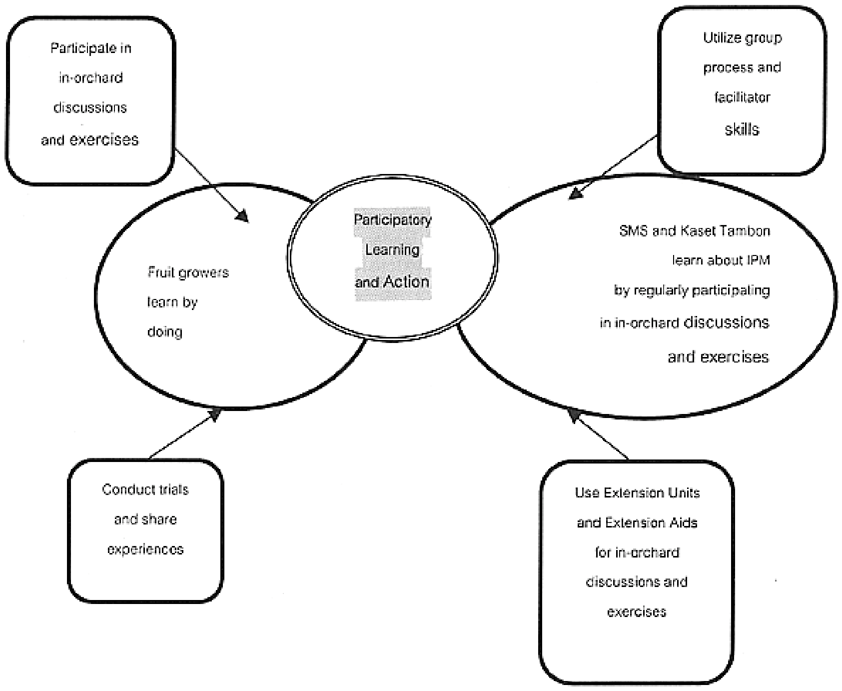
field-based learning. The curriculum also served as a model for learning rice ecology in primary schools under the Office of Primary Education Commission, Ministry of Education.
Since 1996, manuals for IPM in fruit crops, including durian, mango, tangerine, and pomelo, were published to serve as guidebooks for Subject Matter Specialists (SMSs), extension workers and farmer leaders. Later, the IPM field guides on durian, mango and soybean were distributed to extension workers nationwide.

CURRICULUM DEVELOPMENT FOR IPM TRAINING

1. IPM Training in Selected Fruit Trees.

In late 1989, the Department of Agriculture Extension (DOAE) and the Department of Agriculture (DOA), in cooperation with the Thai German Project (GTZ), initiated the IPM Programme in Selected Fruit Trees. The crops included durian, mango, pomelo and tangerine. During the first phase of two-and-a-half years, the project emphasised pest monitoring and collecting data on pests, natural enemies and the economic parameters. In the second implementation phase, from 1994 onwards, the project focused on extension strategies and launched the IPM extension programme in the Eastern Region of Thailand. This programme took on a participatory learning approach, with emphasis on how to work together with the durian and mango growers. The respective Working Groups produced the curricula for these crops. Members of the Working Groups comprised of SMSs from Provinces in the Eastern Region, staff of the Regional Plant Protection Office, and personnel from the Plant Protection Service Division. The curricula consisted of extension unit modules, each dealing with a specific topic. All unit modules described the steps and methods to help growers learn and to apply what they have learnt. In practice, field-level extension agents (or Kaset Tambol) and SMSs learned together with the fruit growers. The former has the responsibility to facilitate the meetings, which were held regularly with the fruit growers in the orchard where the learning took place (Figure 2).

Figure 2. Elements of Participatory Learning and Action**.**
(Source: Arthur DelVecchio, 1995)



2. IPM Training in Rice and Vegetables

This more-recent approach to IPM in rice and vegetables has been implemented nationwide. It started in 1998 under the Royal Initiative with technical assistance from the FAO Programme for Community IPM in Asia and the Inter-Country Programme for the Development and Application of Integrated Pest Management in Vegetable Growing in South and South-East Asia. In this approach, there are four basic principles in the practice of IPM, namely, (1) Grow a healthy crop, (2) Observe the field weekly to determine management actions, (3) Conserve natural enemies, and (4) Farmers become experts in their fields. The IPM paradigm shifted from technology components to ecosystems. An important concept of this new approach is to develop human resource capacities through season-long training for farmers in the so-called Farmer Field Schools (FFS) and for extension agents in Training-of-Trainer (TOT) courses. The strategies to this approach are:

2.1 Curriculum Development for Trainers:

Curricula in rice and vegetables (cabbage), consisting of learning processes and skills needed to facilitate farmers, are produced for the season-long training.

2.2 Training of the Trainers (TOT):

TOT courses are designed to prepare the trainers and extension agents to conduct FFS training. In the conventional training, the role of the extension agents is to deliver the messages and instructions to farmers. Under this new strategy, the extension agents will have to change their role from instructors to facilitators. The methods used during the TOT training are the same as those to be used in facilitating the farmers. Essentially, they are trained to develop technical and facilitation skills in order to lead the learning-by-doing activities with farmers. The training schedule consists of three days at the training site and the other two days conducting FFS in a selected farm.

2.3 Farmer Field Schools (FFS):

The FFS is a school without walls, where farmers come together on a weekly basis to learn about IPM. The duration of the FFS training is for the whole cropping season, from planting to harvest. Farmers work in different groups to conduct agro-ecosystem analysis, including data analysis and presentation, make field observations, study special topics and participate in group dynamics. Special topics are discovery learning activities based on the needs of the farmers or on the immediate problems in the fields.

2.4 The Field Guide:

The Field Guide is the curriculum for farmer training developed from the experiences gained in conducting FFS by facilitators. It is the collection of discovery-based exercises using experiential learning and empowerment approaches.
At present, a total of five TOT courses have been conducted, three in rice, and two in vegetables (cabbage and chinese kale). The facilitators comprised of 100 graduates from the DOAE and 15 others from the Department of Non-Formal Education. Under the DOAE, a total of 76 FFSs have been conducted throughout the country, 64 in rice and 12 in vegetables.

PROSPECTS

1. By this year, expansion of the training activities will include:
   - Conducting four TOT courses in rice and one in vegetables.
   - Conducting 102 FFSs; 42 FFSs in rice and 60 FFSs in vegetables.

2. The concepts of the new IPM approach (grow healthy crops, observe field weekly, conserve natural enemies, and farmers understanding ecology as experts in their own fields) will be expanded to other economic crops such as tomato, yard bean and soybean.
3. Farmer graduates from FFSs will organize Farmer-to-Farmer training for other local farmers.
4. Problem-solving experiments and ecological knowledge developed by trained farmers to be disseminated among the farmer communities to help sustain IPM agricultural practices.

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PEST MANAGEMENT CURRICULUM AT KASETSART UNIVERSITY

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ABSTRACT

Kasetsart University (KU), a state university among the present 24 public and 43 private universities and institutions in Thailand, has established seven campuses that are distributed to cover the main regions of the country. The teaching curricula include many subject areas covering agriculture, science, arts, social science, humanity, education, engineering, and architecture. Recently, the university has also included medicine and health science.

The Faculty of Agriculture consists of nine departments offering various undergraduate and post-graduate study programmes. For the four-year undergraduate programmes, seven kinds of degree courses are offered. Pest Management, an inter-departmental programme, is one. It is designed for students with a career interest in science and technology in pest management. The students conduct inter-disciplinary studies with insects, plant diseases, weeds and other pests, with an emphasis on management systems that are sustainable, as well as, ecologically and economically sound.

Since establishment in 1986, the pest management curriculum at KU has been evaluated a number of times. The problems of students are: (i) they lack agriculture practical training, (ii) they found difficulty in writing scientific papers, (iii) they have problem with foreign language training, and (iv) they have limited choice in the subjects they want. The new four-year Pest Management curriculum, established in 1998, requires a total of 139 credit hours; 31 credits for general education, 102 credits for specific requirements and 6 credits for free electives.

INTRODUCTION

Kasetsart University (KU) was established on 2 February 1943 with the prime aim of promoting subjects related to agricultural sciences. It is a state university within the present 24 public universities and institutions and 43 private universities and institutions in Thailand. (For more information, please see the website http://www.inter.mua.go.th and http://www.ku.ac.th). KU has revised its curricula and expanded the subject areas to cover science, arts, social science, humanity, education, engineering and architecture. Recently, the university has also included medicine and health science. KU has established seven campuses that are distributed to cover all the major regions in Thailand. At present, the number of enrolled students at all levels of study is 23,000. Today, KU has 13 faculties, a graduate school, several institutes and a number of offices, including the Australian Studies Center (ASC) that was set up in late 1994.

The Faculty of Agriculture is one of the faculties of KU established at its inception in 1943. It currently conducts teaching and carries out research in both the Bangkhaen and the Kamphaengsaen campuses. The Faculty consists of nine departments, i.e. Agricultural Extension and Communication, Agronomy, Animal Science, Entomology, Farm Mechanics, Home Economics, Horticulture, Plant Pathology and Soil Science. Through these departments the faculty offers various undergraduate and graduate study programmes with a total of about 3,000 students. For the undergraduate programmes, seven four-year curricula are being offered. One is the degree of Bachelor of Science in Agriculture with seven fields of emphasis (Agricultural Extension and communication, Animal husbandry, Agronomy, Entomology, Horticulture, Plant Pathology and Soil Science). Others are degrees for Bachelor of Science in Animal Science, Agricultural Chemistry, Agricultural Biotechnology, Farm Mechanics and Home Economics. There is also an interdepartmental programme leading to a Bachelor of Science in Pest Management. Presently in Thailand, the King Mongkut's Institute of Technology Ladkrabang and Prince of Songkla University also offer Bachelor degree programmes.

The Pest Management programme in the Faculty of Agriculture at KU is designed for students with a career interest in the science and technology of pest management. Students in the programme conduct inter-disciplinary studies on insects, plant diseases, weeds and other pests, emphasizing the development of management systems that are sustainable, ecologically acceptable and economically sound. The inter-disciplinary nature of the programme is reflected in the involvement of, and sponsor by, several relevant and different departments, in particular Agronomy, Entomology, Horticulture and Plant Pathology.

Graduates are expected to have a broad knowledge on matters in agriculture and horticulture, including the major pests of important plants. They should be able to diagnose pest problems and recommend acceptable management measures to overcome the problems. They should be well versed in the pest management concept, capable of identifying pests and their injury symptoms, and are able to understand economic implications when making decisions on follow-up actions. Moreover, graduates are made aware of up-to-date and technologically advanced pest management tactics, and are guided to become skillful in applying them. Students educated in pest management may find employment opportunities with government agencies, agricultural chemical companies, or other concerns that produce, process, and market the nation's food and fiber. They may also work directly with farmers or in other farm level activities. The old pest management curriculum at KU was established in 1986. Students must complete 149 credit hours and undergo at least 300 hours of training programme. Table 1 summarizes the curriculum for the Pest Management course.

Table 1. Structures of the old (1986–1997) and new (1998-up to date) Pest Management Curriculum.

No.	**Courses**	**Credits**	
		old	**New**
1	General Education	64	31
	1.1 Science and Mathematics	37	7
	1.2 Language	9	12
	1.3 Social Science and humanity	16	10
	1.4 Physical Education	2	2
2	Specific Requirements	76	102
	2.1 Core Courses	33	56
	2.1.1 Science group, 31 Cr.	-	
	2.1.2 Agricultural group, 25 Cr.	-	
	2.2 Major courses	31	-
	2.3 Minor courses	12	-
	2.4 Specific courses	-	37
	2.5 Specific electives (4 groups)	-	9
3	Free Electives	3	6
4	Training Course	6	*
	Total minimum requirement	**149**	**139**

* These are already included in other specific courses.

Over the last few years, the Pest Management programme has encountered a number of problems. For students in particular, they (i) lack agriculture practical training, (ii) found difficulty in writing scientific papers, (iii) have problem with foreign language training, and (iv) have limited choice in the subjects they want. These have been recognized by both the faculty members and the university administration. Even though the pest management curriculum at KU has been evaluated a number of times since establishment in 1986, a review was again made in 1996 to examine the courses and requirements to ensure that students can fully benefit from the new Pest Management curriculum. The new four-year Pest Management curriculum, finalized in 1998, requires a total of 139 credit hours; 31 credits for general education, 102 credits for specific requirements and 6 credits for free electives. Students need to maintain a grade point average of at least 2.00 (or better) on the scale of four points in order to qualify for the degree in Bachelor of Science (Pest Management). More details of this curriculum are as shown in Table 2.

Table 2. Curriculum for Bachelor of Science (Pest Management) with total minimum requirement of 139 credits.

1.	**Basic Requirement**			**(31 credits)**
	1.1	Science and Mathematics, 7 credits		
		- 420119	Abridged Physics, 4 credits	
		- 999xxx	Integrated course in Science and Mathematics group, 3 credits	
	1.2	Language		**(12 credits)**
		- 355111	Foundation English I (do not count for the credit)	
		- 355xxx	English, 9 credits	
		- 999021	Thai Language for communication, 3 credits	
	1.3	Social Science and Humanity		**(10 credits)**
		- 102181	Introduction to Economics, 3 credits	
		- 371111	The use of Library Resources, 1 credit	
		- 999xxx	Integrated courses in Social Science, 3 credits	
		- 999xxx	Integrated course in Humanity, 3 credits	
	1.4	Physical Education		**(2 credits)**
		- 175xxx	Physical Education activities, 1, 1 credits	
2.	**Specific Requirement**			**(102 credits)**
	2.1	Core Courses, (56 Credits)		
	2.1.1	Science groups, 31 credits		
		-	401114 General Botany, 3 credits	
		-	403111 General Chemistry, 4 credits	
		-	403112 Laboratory in General Chemistry, 1 credit	
		-	403221 Organic Chemistry, 4 credits	
		-	403222 Laboratory in Organic Chemistry, 1 credit	
		-	416311 Principles of Genetics, 3 credits	
		-	417116 Elementary Applied Mathematics, 4 credits	
		-	419211 General Microbiology, 3 credits	
		-	419214 Laboratory in General Microbiology, 1 credits	
		-	422111 Principles of Statistics I, 3 credits	
		-	424111 Principles of Biology, 3 credits	
		-	424112 Laboratory in biology, 1 credit	
	2.1.2	Agricultural groups		**(25 credits)**
		-	015111 Overview in Agriculture, 1 credit	
		-	015151 Computer for Agricultural Science, 2 credits	

- 015211 Agricultural Extension and Technology Transfer, 3 credits
- 015221 Animal Science and Technology, 3 credits
- 015231 Crop Science and Technology, 2 credits
- 015241 Introduction to Entomology, 3 credits
- 015251 Agricultural Machinery and Equipment, 3 credits
- 015261 Soil Science, 3 credits
- 015271 Horticultural Science and Technology, 2 credits
- 015281 Introductory Plant Pathology, 3 credits

2.2 Specific courses **(37 credits)**

- 004312 Economic Entomology, 3 credits
- 003419 Weed Biology, 2 credits
- 008481 Diagnosis of Plant Diseases, 3 credits
- 011399 Practice in Pest Management I, 2 credits
- 011411 Fundamental of Pest Management, 3 credits
- 011451 Ecology of Crop Pests, 3 credits
- 011471 Pesticides and Their Application, 4 credits
- 011497 Seminar, 1 credit
- 011498 Special Problems, 2 credits
- 011499 Practice in Pest Management II, 2 credits
- 119111 Introduction to Agricultural Economics, 3 credits
- Choose 9 credits from the following courses
  - 011431 Vertebrate Pests of Agricultural Crops, (3 credits)
  - 011432 Natural Enemies of crop pests and Management (3 credits)
  - 011433 Plant Protection Laws (2 credits)
  - 011441 Management of Economic Crop Pest, (4 credits)
  - 011443 Postharvest Pest Management, (3 credits)
  - 011452 Forecasting of Pest Outbreaks and Crop Loss Assessment, (3 credits)
  - 011472 Pesticide Application Technology, (3 credits)
  - 011491 Research Methodology in Pest Management, (3 credits)
  - 011496 Selected Topics in Pest Management, (1–3 credits)

2.3 Specific electives **(9 credits)**

Choose 1 branch from the total of 4 branches.

2.3.1 Agribusiness branch **(9 credits)**

Choose 9 credits from the following courses:

- 009221 Principles of Farm Management
- 119331 Principles of Agricultural Marketing
- 119371 Introduction to Agribusiness
- 119372 Agribusiness Process
- 131211 Business Finance
- 132111 Principle of Management
- 132141 Introduction to Business Law
- 145111 Principles of Marketing
- 355233 Correspondence

2.3.2 Research branch **(9 credits)**

Choose 9 credits from the following courses:

- 011491 Research Methodology in Pest Management
- 355224 Technical English
- 401351 Introductory Plant Physiology
- 402311 Biochemistry I
- 402312 Laboratory in Biochemistry I
- 402312 Statistical Analysis and Experimental Designs
- 422427 Statistical Analysis Using Statistical Packages

2.3.3 Agricultural Environment branch **(9 credits)**

Choose 9 credits from the following courses:

- 003421 Plant Climate
- 004461 Insect Ecology
- 009422 Soil and Plant Relationship
- 009472 Soil and Water Conservation
- 009481 Soil Pollution and Its Management
- 119405 Economics of Sustainable Agriculture
- 301201 Resource and Environmental Conservation
- 355224 Technical English
- 401481 Plant Ecology
- 422411 Statistics for Environmental Science

2.3.4 Specific person branch

Choose 9 credits from any courses in KU. Students wishing to choose this branch must plan the courses with the advisor. After consultation with the advisor, the Chairman of Pest Management and Dean of Faculty of Agriculture will be assigned, depending on the interest of the student. The student should finish this process within first semester of the third year programme.

3. Free elective 6 credits

In conclusion, it is pertinent to point out that to many Thai educators today, an adequate Agricultural Education means students should at least be able to understand both the pure and applied scientific research in agriculture in support of the National Economics and Social Development Plan. Also, during their undergraduate education they should have sufficient exposure beyond their specialist areas. The necessary steps in restructuring the Pest Management Curriculum have been made to ensure that these main goals can be achieved.

FROM PASSIVE OBSERVER TO PEST MANAGEMENT EXPERT: SCIENCE EDUCATION AND FARMERS

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ABSTRACT

The failure of the chemical control paradigm to resolve issues relating to resistance, resurgence, secondary pest outbreaks and hazards to health and the environment have resulted in a shift to an IPM paradigm. A further shift occurred at the implementation level.

A programme to help farmers understand science was launched in 1989. To achieve this, 30 field trainers learned to facilitate learning at a residential season-long Farmer Training Facility (FTF). FTF graduates appreciated that science has to be learned and not told by IPM practitioners.

Twenty to thirty farmers meet for weekly sessions of about six hours each during a rice season at a Farmer Field School (FFS). Learning to experiment often results in farmers knowing more about the ecosystem. They use this knowledge to analyse the ecosystem. To meet the challenges of maintaining quality education in science, it is necessary to develop Action Research Facility (ARF) and follow-up farmer studies. This enables farmers, researchers and extension workers to become research partners.

INTRODUCTION

For decades, the *modus operandi* in agricultural development, particularly in third world countries, has been a top-down "tell farmers what to do" approach. Researchers would develop new technology in the research station and this would be transferred to farmers. Often farmers had no say when development packets are thrust on them. This approach was so ubiquitous that a young scientist starting a career in plant protection in the early 1970s would hardly need to meet farmers/clients. The linear approach of extending technology was promoted internationally and developing infrastructures to support this extension approach was a priority in many developing economies. Roling & van der Fliert (1994) noted that extension became a "delivery mechanism" for science. Such an approach has not really benefited resource-poor farmers (Chambers et al., 1989). Nowhere is this more apparent than in the case of rice cultivation in South and Southeast Asia. The evolution of Integrated Pest Management (IPM) implementation in rice provides a good setting to discuss the problems associated with a top-down process and the shift towards farmer education. In particular, a specific case concerning the development of the brown planthopper (BPH), *Nilaparvata lugens* Stål (Hemiptera: Delphacidae) as a serious pest of rice following intensification in rice cultivation is noteworthy (Kenmore et al., 1984; Ooi, 1986). Lessons learned from implementing IPM in rice and other crops in the region provided the impetus for the evolution of methods used to educate farmers about science. This is a challenging subject because a complex concept such as IPM has resulted in a wide array of definitions and approaches (Moore, 1996). As a result of this, Kogan (1998) pointed out that the term "IPM" is now a household word and being used by so many people.

Despite its wide acceptance, IPM remains a complex issue (Schmidt et al., 1997). Historically, IPM has its roots in entomology. Perkins (1982) pointed out that entomology is both science and technology. The technological aspect of entomology is the complex part that led to competing approaches toward pest control. Moore (1996) highlighted the various interpretations of IPM and warned of the dangers of being caught in semantics and wander away from the very basis upon which IPM was first developed. This is not surprising as IPM has evolved in the last fifty years from a technical mix of various components (Stern et al., 1959; Smith and Reynolds, 1966; Bottrell, 1979; Kenmore, 1987) to a farmer-led programme (Dilts and Pontius, 1999). Successful IPM has always followed an ecological approach (Kogan, 1998). The Food and Agriculture Organization of the United Nations (FAO) Programme for Implementation of IPM in rice in Asia provides a unique opportunity to examine an approach that focused on small-scale farmers understanding ecological science to achieve a more stable and sustained production of agricultural crops.

A PARADIGM SHIFT

Following the discovery of chemical insecticides in the late 1930s and early 1940s, spraying insecticides quickly became the dominant paradigm in pest control (van den Bosch, 1978). The chemical control paradigm quickly underwent a crisis because it could not successfully handle the problems of resistance, resurgence, secondary pest outbreaks, and environmental and health hazards (Perkins, 1982). Alternatives to the chemical paradigm developed. However, many of the early alternatives focused on developing better technology and very little on implementation. Hence, there were large investments in developing resistant plant varieties. For example, when there were large outbreaks of BPH, there was a rush to develop resistant varieties. Recognising that insecticides can cause BPH outbreaks, the strategy was to develop rice varieties that were not preferred by the BPH, and hence, reduce the pest problem. However, developing plant resistance to BPH did not result in reducing the use of insecticides as farmers were encouraged to spray for other insects. BPH resurgence persisted until widespread appreciation of natural enemies became the norm. Similarly, developing passive economic threshold levels (ETLs) did not help farmers understand field ecology. Hence, farmers were told by researchers and extension specialists to spray insecticides when they noticed 7 BPH/hill in their rice fields. In reality, the perceived message was about use of insecticides and many rice farmers sprayed their fields at the first sign of BPH. Thus, IPM based on the use of ETLs actually led to more insecticide sprays in rice fields, disrupting biological control, thereby causing more resurgence and secondary pest outbreaks. There were also attempts to improve sampling, such as using sequential sampling, but these did not go beyond research stations, even with “simplified” peg boards.

It follows that within the larger paradigm shift, there was another paradigm shift within IPM. This occurs at the level of implementation. Right up to 1980s, IPM implementation was a centrally-controlled activity where farmers were told what to plant when to plant, when to spray and what to spray, a “delivery mechanism” extension (Roling & van der Fliert, 1994). Initially, the FAO Inter-Country Programme adopted this approach at the time of inception in 1980. However, it became increasingly clear that an implementation programme where farmers were not involved directly leave much to misunderstanding, abuse and eventually led to further resurgence of BPH. While the objective was to reduce the amount of insecticides used in rice, the opposite very often occurred. Simple messages in the form of a “participatory” strategic extension campaign (Adhikarya, 1994) did not educate farmers to understand ecology and invariably led to greater dependence on chemical control. Ecological knowledge of BPH was known for a decade (Kenmore et al., 1984; Ooi, 1986) but had little impact on farmers for they did not have a chance to learn about it.

Recognising that extensive use of insecticides have led to food insecurity, the President of Indonesia signed Presidential Decree 3/86 (Wardhani, 1992). The decree banned 57 insecticides from rice fields and removed subsidy for pesticides. This cleared the rice environment of numerous disruptive insecticides to enable the development of IPM education for farmers (Dilts and Simon Hate, 1996). Matteson et al. (1994) pointed out that learning in a group using conventional teaching methods with field demonstrations and class experiments was reported earlier by Goodell et al. (1981). A focus on understanding rather than following instructions or adopting a package is basically still little understood then. Four methods to teach science to farmers emerged during IPM implementation in Indonesia from 1990. These methods did not develop all at the same time but evolved as the new implementation programme gained momentum and built on experiences gained.

FARMER TRAINING FACILITY (FTF) APPROACH

The Indonesian Presidential Decree of 3/86 was promulgated on the basis of a wealth of information that resurgence of BPH and other rice insect pests will occur following the widespread use of insecticides. Immediately following the decree, the concerned authorities embarked on a campaign, ordering farmers to avoid using restricted insecticides and to use only approved insecticides when BPH reached the ETL. It was clear to rice ecologists that the pest problem would remain as long as farmers did not understand the cause of outbreaks. With support of top policy makers, a decisive move was made to re-educate plant protection field officers on educating farmers. This trainin programme was held in what became known as a Farmer Training Facility (FTF). The philosophy adopted was based on the notion that “Trainers will teach in the way they were taught”. Much of the re-learning focused on learning from farmers and this understanding fostered respect for farmers.

This FTF approach is a fully residential and season-long programme aimed at understanding how insecticides cause resurgence of the BPH. Essential to the FTF process is the selection of issues related to rice production. In 1989, the main issue was the worst pest of rice, the BPH, which threatened food security. With the help of resource persons from the International Rice Research Institute (IRRI) and national research institutions, experiments were planned to help trainees carry out scientific studies to determine mortality factors that keep BPH and other rice herbivores in check. Trainees also carried out experiments to understand plant physiology and appreciate the concept of plant compensation. While the initial focus was on rice, knowledge was also built from other crops grown after rice (“palawija”). To unlearn the top-down delivery mechanism, it was necessary to pick up new skills in facilitating learning, group dynamics, inter-personal relationship, management and planning besides skills in carrying out field and classroom experiments. The Government of Indonesia invested time and money to develop a cadre of IPM trainers who are confident in working with farmers as their equals.

To achieve this mutual respect with farmers, IPM trainers had to grow a rice crop from nursery to harvesting. Graduates of FTF learned that farmers have been experimenting, possess values and learn better when given the opportunity to discover. Indeed, they developed principles that encouraged farmers to manage their own fields. Their knowledge from studies conducted during the FTF led them to appreciate that science has to be learned and not told by practitioners.

Usually, a FTF has up to 30 field officers. It is an in-service training programme and often officers are fairly senior in service. This form of in-service training is often very different from the ones these officers are used to. In all countries where this approach was initiated, there was initial rebellion within the ranks. Many arrived at the FTF unprepared. The dress code was similar to that of farmers and many were not prepared to walk barefoot in the mud, preparing fields for planting and actually do the planting. However, camaraderie developed and the group realised that they were learning new skills and developing greater confidence that have helped them in their work. Usually four or five groups of trainees were formed and members of each group worked together to carry out experiments, discussed field issues, worked with farmers and eventually developed their own programmes about learning field ecology and how to teach science to farmers. For example, carrying out an exclusion cage experiment in their study sites had allowed the trainers to better appreciate the natural mortality factors that were existing in the rice ecosystem (Ooi, 1996). This invariably led to more cage studies referred to as "insect zoos". The purpose of "insect zoos" was to study the behaviour of an insect and to determine if it was a predator or a herbivore (Ooi et al., 1991). This study can be modified to determine the functional response of a predator to the number of prey consumed. Indeed, the training groups often came out with different results (Ooi, 1996) and this had encouraged critical discussions. In the end, what emerged was a cadre of trainers who have ownership of new-found knowledge concerning the concept of predation. This greatly strengthened their confidence about helping farmers understand predation and biological control in general.

The role of resource persons in FTF is one of helping trainers with the technical aspects of setting up experiments. In addition to providing knowledge, they help trainers to upgrade their skills in carrying out experiments. This process may be implemented outside an FTF. For example, a researcher may work with a team of trainers and helps them set up studies to determine predation of soybean aphids (van den Berg et al., 1997) or study the natural enemies of soybean pod-sucking bugs (van den Berg et al., 1995). An important feature of these studies is that these are conducted in farmers' fields together with farmers. Hence, the trainers will help train other trainers and farmers using similar methods.

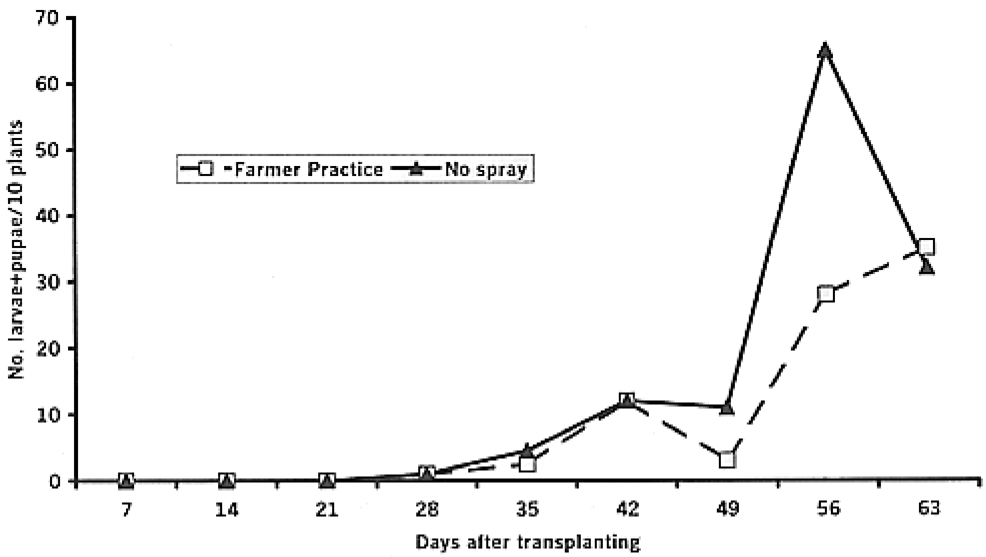
To enhance an ecological understanding in the rice ecosystem, a researcher works with field trainers in fields operated by farmers. They develop the concept of "neutral insects" that help explain why general predators continue to be effective in the rice field when no pest species is apparent (Settle et al., 1996). The ecological research is necessary in the light of misinformation from certain quarters concerning the role of natural enemies, particularly general predators in the rice field.

The FTF approach underwent further evolution when it was taken out of Indonesia. In Bangladesh, China and the Philippines, various forms of the FTF approach were experimented and it was finally agreed that a full season residential training was necessary to achieve the expected quality of a "facilitator". In Vietnam, the FTF approach assumed the name of Training-of-Trainers (TOT) and was modified to include simultaneous implementation of Farmer Field School (FFS). Each group in the FTF had to organise an FFS during the season. In fact, this modified version is the main one adopted today in Nepal, Cambodia, Sri Lanka, Thailand and Lao PDR. Building capability and capacity of national programmes to run FTF or TOT is an important aspect of IPM implementation. Only nationals who possess the local language, local know-how and working with local farmers are able to set up quality farmer education in their countries.

A FTF, besides teaching fundamentals of agro-ecology and non-formal education (NFE) processes, is a versatile tool used to bring trainers to work with farmers. In Indonesia, it facilitated the development of curriculum for IPM in field crops grown after rice ("palawija"). In 1994, the Vietnam National IPM Programme embarked on IPM in Vegetables. However, IPM trainers only had experience in rice and were not comfortable about setting up a TOT for vegetable IPM. It was decided that to upgrade skills in vegetable IPM, some experienced rice IPM trainers would be selected to learn more about cabbage, tomato and bean cultivation. A small FTF was set up near Hanoi and based at a station surrounded by vegetable farms. Trainers learned from farmers on cultivating the three crops. They also talked to researchers from the university and the national agriculture research organisations. Information provided were used to plan studies to be conducted in the fields owned by farmers. Trainers had to carry out the FTF for two seasons before they were sufficiently confident in organising a TOT for their colleagues. They planned the curriculum based on studies they have carried out. This approach to learning and obtaining knowledge proved useful in isolated sites such as Dalat, a highland vegetable growing area. It was assumed that the diamondback moth, a serious pest of cabbages, should be controlled by regular treatments with chemical insecticides. To test this assumption, trainers in Dalat organised a study with farmers. They compared sprayed (based on farmer practice) and not sprayed fields of cabbages. After a season, they realised that the population of the diamondback moth was really not serious and prophylactic sprays may not be necessary. This method of testing assumptions helped the trainers to plan IPM teaching curriculum for farmers. Weekly samplings were carried out using visual counts for the pests and using pitfall traps to trap spiders on the ground. The study showed that it was necessary to understand what was happening in the field before interventions were made. As noted in Figure 1, the chemical insecticides had adverse effects on spiders (based on pitfall trap catches). The population of the diamondback moth was similar in both situations.

A similar situation was observed in Nepal when the Plant Protection Division embarked on IPM with initial support from an FAO Technical Co-operation Programme. Field trainers were concerned that they did not understand rice field ecology and recent outbreaks of BPH in Chitwan (Terai) caused much anxiety. Supported by the FAO Intercountry Programme, some trainers were selected to initiate field studies at the village where BPH outbreaks were reported in 1996. It was necessary to build up a database on field ecology before a FTF could be set up. Five trainers were stationed in a district in Chitwan to work with farmers there. Farmers were thrilled to work with the trainers in their fields and despite some initial problems with field experimentation, the trainers learned that contrary to widespread beliefs, the BPH was not a problem in fields that were not sprayed (Figure 2). Predatory spiders and mirids appeared to have kept the BPH in check. Armed with knowledge acquired during the study, the trainers were able to work with IPM trainers from the Philippines to develop a TOT the following season. When we returned to the same village two years later, the farmers remembered what they have learned and what was most interesting was that they were carrying out experiments on their own to discover more natural enemies and selecting better rice varieties. No further outbreak of BPH was reported in the area.

(A)



(B)

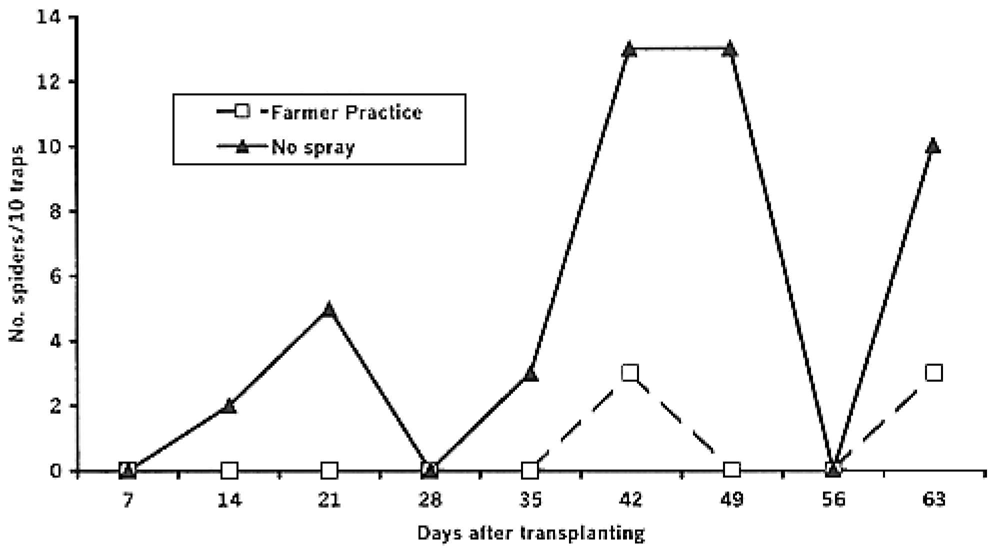


Figure 1: Results of a field study by a team of Vietnamese IPM trainers in Dalat in 1995 to understand the impact of chemical insecticides on the diamondback moth (A) and on spiders (general predators) (B).

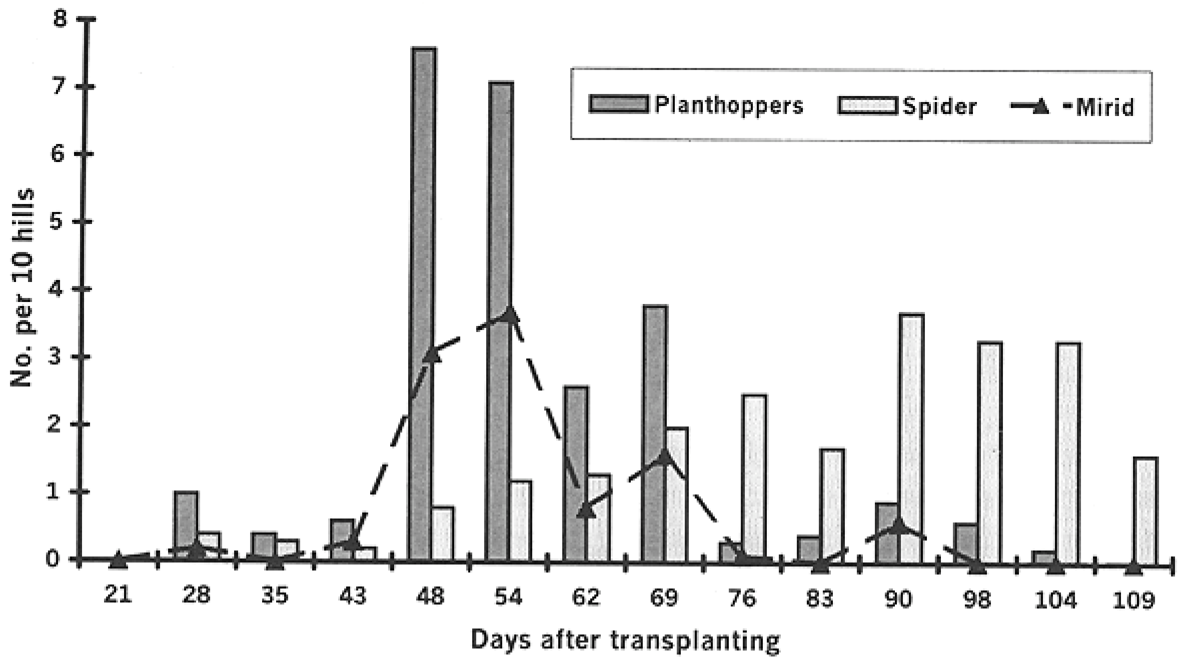


Figure 2: Weekly data from a field owned by Mr. Aryal collected by both farmers and trainers at Kharkhute, Kathar, Chitwan, Nepal.

FARMER FIELD SCHOOL (FFS) APPROACH

FFS is a season-long learning experience attended by 25 to 30 farmers (Dilts and Pontius, 1999). Trainers from FTF or TOT are equipped to facilitate learning in FFS in their duty stations. In the FFS, farmers learn about the agro-ecosystem. To do this, the rice field is the field laboratory where farmers learn ecology by means of regular observation and testing hypothesis.

The FFS is a participatory learning process (ter Weel and van der Wulp, 1999). The process emphasises taking decisions and actions based on an open discussion of ideas. Facilitators ensure that the process is not dominated by any individual. Every decision made in the FFS can be tested in the field. The FFS process also provides participants with an opportunity to examine human social dynamics. As a result, FFS participants not only learn about the cause-and-effect relationships that exist in the rice field (ecology), but they also acquire a greater understanding of human relationships (Dilts and Pontius, 1999). It is not an end in itself, but really the beginning of an educational adventure.

The FFS process was very well received by farmers when it was first introduced in Indonesia (Oka, 1997). Farmers welcomed the process where they are asked to think. For example, a common outcome when they walked into the field to pick up bugs or diseased plant parts was to ask “What is this?”. The good facilitators did not give direct answers and to the surprise of the farmers they were asked a question instead of receiving an answer. Facilitators asked “Where was it found?” Farmers were forced to recall where they found the specimen and initiated a conversation. Through a series of questions and answers, the farmers wanted to find out the nature of the specimen collected. In the case of a bug, the farmer was encouraged to find out the function of that bug using an “insect zoo”. Hence, a process of looking for answers was developed. This study helped to enhance the power of observation of the farmers. Examples of other questions asked were “How many legs are present? What is the shape and colour of the bug? Where is it found?”. This discovery process may be undermined by a “recipe” approach towards learning. In some FFS, the curriculum was formulated by trainers based on “Field Guides” with little reference to field situations. This led to poor attendance, as the FFS did not address the concerns of the farmers. Further information on implementation of FFS may be obtained from Matteson et al. (1994), Roling and van der Fliert (1994), Dilts and Simon Hate (1996), Schmidt et al. (1997), ter Weel and van der Wulp (1999) and Dilts and Pontius (1999).

Developing an ecological understanding helps participants to analyse the ecosystem weekly. Usually five groups of five participants each will carry out weekly field observations. They observe the growth of the crop, measure its development, check for level of water and record the weather. Based on “insect zoo” results, farmers would be able to separate the pests from the natural enemies. Having done that, they would draw what they have observed and present their findings. By this time, the group would have arrived at a decision about the condition of the field. This will be discussed with members of the other groups. The analytical processes employed in the FFS enhance farmers' capacities to examine the conditions where they live and work (Dilts and Pontius, 1999). Participants, having completed their FFS, are able to take decisions and act to improve on those conditions. Many graduates of FFS go on to become farmer trainers and have organised workshops to share knowledge from scientific studies.

Besides field observation, farmers work with IPM trainers to set up comparative studies to compare sprayed and unsprayed plots. As with all studies in FFS, these should be developed after farmers have shared their views about their practices. Trainers would treat their beliefs as hypothesis and request that these be tested. This method of testing hypothesis is popular, as many farmers did not recognise the hazards of using chemical insecticides. It encourages critical thinking. Some basic field experiments include exclusion cages, defoliation and removal of tillers. They provide answers to the more common questions raised by farmers. The purpose of a defoliation study is to test the hypothesis that plants have compensation mechanisms against defoliators (Figure 3). Hence, participants of an FFS in Piem Ro, Prey Veng Province, Cambodia were able to show that up to 75% defoliation of rice plants even at 60 days after transplanting did not cause much yield loss (Table 1). The results helped farmers to conclude that early season spray at the first sight of herbivores may not be necessary. It was not surprising that farmers who were just told not to spray in the first 40 days were motivated to attend the FFS (Huan et al., 1999) where they could learn about this and other concepts.

Figure 3: Farmers in a Farmer Field School in Vietnam setting up an experiment to test the effects of defoliation on yield of rice plants.

Table 1: Results of a defoliation study by farmers attending a Farmer Field School at Piem Ro, Prey Veng Province, 1996. Rice variety used was IR 66.

Treatment	**Yield kg/ha**		
%defoliation	At 15 DAT	At 30 DAT	At 60 DAT
0	2513 ± 95	2488 ± 25	2475 ± 65
25	2488 ± 85	2475 ± 65	2500 ± 41
50	2450 ± 58	2643 ± 85	2450 ± 41
75	2425 ± 87	2425 ± 65	2438 ± 48

At an FFS, farmers are able to test whether insect pests would wipe out a no-spray plot. In more than 99% of the FFSs conducted in nine countries, the results have always been the same, no insecticides no pest outbreak. An examination of comparative studies in FFSs conducted in Cambodia in 1995 suggested that rice yields were either similar or better than in sprayed plots (Figure 4). Such positive re-enforcement from their studies have helped to develop confidence in farmers to carry out more studies. In all countries where FFS have been adopted as the preferred method to educate rice farmers, threats of outbreaks of BPH declined, and often, higher yields were achieved. Farmers were able to talk to regional and national policy makers about what they learned and this convinced policy makers to avoid policies that threaten the ecology of the rice field.

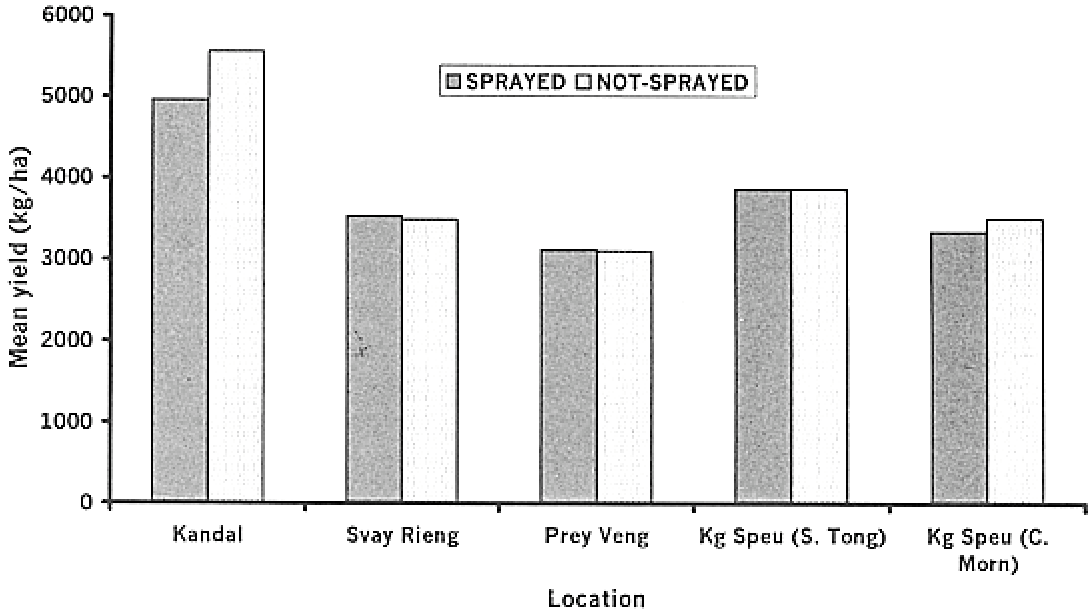


Figure 4: Mean rice yield compiled from comparative studies conducted in FFSs from five localities (four provinces) in Cambodia during the Dry Season 1995.

Despite the positive lessons learned from FFS implementation (Dilts and Pontius, 1999), there are also concerns that not all IPM trainers conduct FFS in a participatory manner. The quality of FFS implementation can be determined only by visiting on-going activities or discussion with FFS graduates. To facilitate this evaluation (often self-evaluation), Pontius (1999, pers. comm.) suggested a quality matrix which is summarised in Table 2. Recognising variations in quality of FFS implementation, steps were taken to reduce the gap between farmers who received a good education and those who continued to receive a top-down lecture. Management workshops for graduates of FTF every six months have helped to facilitate the process of ownership of IPM implementation. At the same time, efforts were made to encourage science education through Action Research Facility (ARF) and follow-up farmer studies.

Table 2. Quality matrix for learning IPM in Farmer Field Schools developed by John Pontius (1999, personal communication).

Activity in FFS	**Indicators of Quality**
What is this? Dialogue to focus attention on function not name	1. No direct answers given, leading questions asked 2. Function related questions asked 3. Participants able to state or define functional relationships in the agroecosystem
Agroecosystem Analysis Focus on developing good IPM habits Weekly observations Analysis Decision making	1. Process of observation includes the whole plant and surroundings 2. Observations written down 3. Specimens collected 4. Drawing summarized observations 5. IPM trainers pose problems and ask questions appropriate to analysis of drawing 6. Group discussion relating to field conditions and agroecosystem relationships 7. Previous weeks' agroecosystem drawing used for comparison 8. Participants active and working together in small groups

	9. Participants can identify differences between pests and natural enemies 10. Decisions based on levels of insect populations
Special topics Focus on particular aspects of IPM	1. All participants active and involved in the activity 2. Participants can state what they have learned because of the activity 3. Group leader help participants examine the steps towards applying what they learned to real life
Group Dynamics Focus on enhancing team work and problem solving skills	1. All participants actively involved in the activity 2. Trainers help participants identify key learning points based on the activity and ask questions that help participants learn from the experience 3. Participants able to state what they have learned
Ballot Box Evaluating process that is used as pre- and post-test to determine IPM field skills	1. Testing field based knowledge and skills 2. Latin names not used 3. Group leader uses ballot box to reinforce learning, focus in on content not scores

ACTION RESEARCH FACILITY (ARF) APPROACH

Five years after the introduction and adoption of FFS as the primary learning method by the Indonesian National IPM Programme, an approach to strengthen science and farmers was initiated. This approach was set up to encourage farmers facing chronic pest problems to find solutions to their problems. A site was set up in the village of Kalensari in the district of Indramayu, West Java. This site was chosen to address the problem of white stemborer outbreaks that occur annually following prolonged drought. Van der Goot (1925) studied this problem some sixty years ago and discovered that the white stemborer larvae diapause during prolonged drought from August to November. He recommended that farmers avoid planting rice until the larvae break diapause following onset of rain and swarms of the moths have disappeared. Although researchers knew of this information for sixty years, it was not utilised to help farmers solve their problem. On the contrary, farmers were "forced" to purchase large amounts of insecticides in an attempt to control the insect resulting in resurgence of BPH and poor control of the white stemborer. When farmers experimented and re-discovered the concept of diapause, their enthusiasm led them to plan and implement ways to avoid an outbreak of white stem borer (Warsiyah et al., 1999). These farmers were able to convince the district officer to stop forcing insecticides onto farmers. Instead, farmers organised themselves to avoid the peak periods by monitoring rainfall and flights of the moths (Figure 5).

Figure 5: Farmers belonging to an Action Research Facility at the village of Kalensari (Indramayu), checking for moths of the white stemborer at light traps prior to making decisions on time of planting.

A similar ARF was set up in the village of Sambon near Boyolali in Central Java. Farmers were able to manage tungro when they understood how the virus spreads. Information about this has been available for two decades but was not used in favour of chemical control developed by centralised decision-makers. Farmers realised the need to remove sources of inoculum prior to planting and organised blocks of about 10 ha where rice was planted synchronously. Within a season, the tungro problem was solved.

The success of tungro management have encouraged farmers in Sambon to study traditional indigenous knowledge. One such knowledge is the use of rotting meat to attract the rice ear bug. Farmers found the most attractive bait was chicken droppings but these attracted mostly males (Ooi, 1998). Nevertheless, they realised that it could be used to monitor the presence of the rice ear bug.

The ARF's role in helping farmers solve pest problems is now better appreciated by the national research community. The approach has all the qualities described by Waters-Bayer (1989) and Ashby and Sperling (1994). It provides a fresh perspective concerning the nature of agricultural research. This is true when researchers also understand that science has to be learned and not told by practitioners. It cannot be assumed that once scientific knowledge leaves the scientist's desk, it would reach farmers for their passive adoption. National researchers need to provide the opportunity for farmers to re-discover the science behind the recommendations, or better yet, develop science with farmers. The experience from ARF confirms that farmers are knowledgeable and innovative (Bentley, 1994) and shows the need for national agricultural research institutions, the extension services and farmer groups to work together as research partners (Waage, 1998).

FOLLOW-UP FARMER FIELD STUDIES (FFFS) APPROACH

More than 120 case studies of farmer research by FFS graduates in Indonesia were collected when IPM trainers encouraged farmers to continue experimenting. Many of these case studies showed how innovative farmers were. They formulated ideas and set about testing these ideas, and based on their own experiments, came up with conclusions that they could share with other farmers. Some of these studies were reported by Ooi et al. (1999). Also, many more farmer research is continuing to be reported by farmers. Similar developments were reported by Sperling et al., (1993) and Loevinsohn et al. (1994) from their work with Rwandan farmers. Unlike ARFs, there is no concerted effort in Follow-up Farmer Field Studies (FFFS) focusing on any single problem. Often, FFFSs are organised by Farmer Trainers and FFS graduates with minimal support from the national programme.

Besides discovering new knowledge, farmers often use FFFS approach to evaluate recommendations. For example, when the insecticide industry promotes a new kind of insecticide that claims to be friendly to natural enemies, farmers are encouraged to treat the suggestion as a hypothesis to be evaluated.

When outbreaks of BPH were reported in 1998 in North Sumatra, agricultural authorities were concerned that farmers were returning to regular field spraying. Investigations showed that outbreaks of the BPH occurred in fields owned by farmers who did not fully understand IPM. A campaign was launched by certain quarters of the agriculture department to promote use of endosulfan (banned from being used in rice in Indonesia) as a method to control the golden apple snail. Even though farmers knew about alternative methods to manage the snail, marketing and “persuasion” resulted in large-scale use of this insecticide. When the cause of BPH outbreaks was identified, FFS alumni members organised themselves to set up field studies they learned in the FFS and invited other farmers in their community to join in. As in the FFS, farmers realised the adverse effect of using toxic chemicals in the rice field. After a season, the use of endosulfan declined and there was no further outbreak of BPH. This case study exemplifies a way to approach field problems. Like in the ARF, it requires facilitators to work with farmers on problem analysis.

CONCLUSIONS

A paradigm shift from an all-invasive and disruptive chemical control to IPM did not stop there. There is a further shift from a top-down to a more participatory approach in IPM implementation. To achieve this, it is necessary to help IPM trainers (and field workers) to unlearn the top-down habits and adapt to a new role as facilitators of farmer education. The new approach is to provide learning opportunities to farmers. Facilitators learn new skills in FTF and develop confidence in organising FFS where rice fields are the class laboratories. Good facilitators appreciate that science has to be learned and not told by IPM practitioners. Maintaining quality in science education is challenging and there is a need to encourage graduates of FFS to continue experimenting. This is achieved through ARF and FFFS. These approaches provide an opportunity for scientists, extension workers and farmers to work together to solve field problems. It requires a change in mindset to recognise that farmers are knowledgeable, innovative and are always experimenting. With all three groups working as research partners, good science will be perpetuated at the grass-root level.

ACKNOWLEDGEMENTS

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CURRICULUM DEVELOPMENT PROCESS

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ABSTRACT

Currently, many countries spend a sizable portion of the national budget to retrain their extension workers on Integrated Pest Management (IPM) training activities for farmers. These efforts are in response to the national policy, attempts to reduce pesticide use and to consumer demand for residues-free produce. For Thailand, a leading exporter of agricultural produce, the situation is particularly challenging. This is because the international trade agreement demands minimal chemical residues in produce while at the same time farmers are applying large amount of chemicals in their production process. The adverse impact has already occurred with the cancellation of orders of certain fruits from Thailand to Europe and Japan.

In efforts to meet this important challenge, there is an urgent need to reform the educational process of those who are or will be involved in the agricultural field. In particular, graduates who will become part of the extension systems, or working for private sectors, must posses the necessary knowledge and skills to minimize the use of chemical inputs in agricultural production. To do so, they especially need to understand the practical functioning of the ecology of plant-pest-natural enemy ecosystem. Unfortunately, most universities and colleges are weak in this area and continue to use the conventional curricula and teaching methodologies or assessment systems that largely promote memorizing of information and theories. Consequently, the students cannot respond in an innovative way to deal with the field problems that they encounter.

Efforts to reform the educational programmes have often faced obstacles. Currently, the Thai Education Foundation is working with various educational agencies to institutionalize the field-based IPM courses that involve a wide range of students. They include primary school students, young and older adults in Non-Formal Education programmes, and students in agriculture colleges.

INTRODUCTION

Many countries, including Thailand, are spending significant amount of the national budget to retrain extension workers and farmers in effort to reduce the adverse impacts of pesticides and to avoid rejection of food export due to pesticide contamination. To meet this important challenge, there is an urgent need to reform the educational process. Unfortunately, most universities and colleges using conventional curricula and teaching methodologies or assessment systems cannot respond in an innovative way to deal effectively in overcoming the problems encountered.

Efforts to reform the educational programmes have often faced obstacles. Currently, the Thai Education Foundation is working with various educational agencies to institutionalize the field-based IPM courses. This involves a wide range of students that include primary school students, young and older adults in Non-Formal Education (NFE) programmes, and students in agriculture colleges. The many aspects relating to these programme activities, including the educational philosophies and methodologies, are discussed in this paper.

CHARACTERISTICS OF SCHOOL AND COLLEGE CURRICULA

Until today, the characteristics of most traditional curricula used in schools and colleges are rather rigid, top down and formal. The following features are readily recognizable:

- Subjects have no or little connection with other subjects/disciplines.
- Not responsive to diverse needs of learners (interests and learning styles) and real life situations.
- Designed to be taught in classroom setting, i.e. textbooks, lectures, etc. Often, knowledge is given or transmitted by trainers with inadequate skills and experiences built for real-life situations.
- Assessments of the curricula are based on the amount of contents absorbed by learners more than skills and expertise.
- Centralized by the institutions.

TRENDS IN DEVELOPMENT

In recent years, there appears to be changes in the approach to teaching in some of the more innovative schools and colleges. However, most of the learning institutions are yet to recognize the need to move away from the traditional approach. The trends in development for those that have made changes and improvements have included the following:

- Curriculum development as a core procedures rather than theoretical guidelines. It is a logical process which begins with clear goals that reveal value preferences, and when the latter are formalized, these value preferences are referred to as educational philosophies or learning theories.
- Provide holistic view with opportunity for in-depth studies of elements or components.
- Allow for constructing knowledge and skills through experiments and practices.
- Integration that links the contents and skills from various disciplines.
- Responsive to learners (interests and styles) and environmental needs (employment, community and country).
- Decentralized.
- On-going process of field tests and refinements by those who teach/train.
- Assessments that reflect the goals and methodologies are fully built in.

UNDERSTANDING CURRICULUM AND INSTRUCTIONAL LEADERSHIP

An important step towards improving the training approach and methodologies is a good understanding and development of the right training curricula designs. There is also a crucial need for quality instructional leadership. To realize this, it is necessary to comprehend the many educational aspects spanning from developmental behaviours to different theories of learning and how these theories apply to educational leaders. Broadly, the various aspects include multiple intelligence, curriculum integration, constructivism, service-learning, learning organizations, and others. More detailed considerations of these are given below.

Constructivism

Constructivist theory is a general framework for instruction based upon the study of cognition and has roots in philosophy, psychology, sociology and education. Much of the theory is linked to child development research. Constructivism encompasses a number of cognitive and other theories of learning where the learner selects and transforms information, constructs hypotheses and makes decisions. This is done through relying largely on a cognitive structure.

The constructivism's central idea is that human learning is constructed and that learners build new knowledge upon the foundation of previous learning. This view of learning sharply contrasts with one in which learning is the passive transmission of information from one individual to another, a view in which reception, not construction, is the key.

Progressive Education

John Dewey was one of the founders of progressive education. It embraced industrial training, agricultural and social education, and educational theorists' new instructional techniques. The "progressives" insisted that education is a continuous reconstruction of living experience, with the child being the centre of concern. John Dewey maintained that schools should reflect the society. In education, he opposed the traditional method of learning by memory under the authority of teachers. He believed education should be concerned with manual skills, the interests of the students, current problems, as well as, the mind. He stated that education must include a student's physical and moral well-being, in addition to his/her intellectual development.

Theory of Cognitive Development

Jean Piaget (1896–1980), a Swiss biologist and psychologist, began to study human development in the 1920s. His research had one unique goal … how does knowledge grow? His answer is that the growth of knowledge is a progressive construction of logically embedded structures. These structures supersede one another by a process of inclusion where lower and less powerful logical means expand into higher and more powerful ones until adulthood. Piaget stressed the holistic approach. A person integrates new information into existing files, or "schema" (hierarchical categories), through many channels, such as, reading, listening, exploring and experiencing his/her environment.

The following illustrates Piaget's Stages of Cognitive Development and the Hierarchy for Instruction:

Knowledge	Facts
	Ideas
	Concepts
Reflective, Thinking	Interpretation of Data
	Application of facts & principles
	Logical reasoning
Values & attitudes	
Sensitivities & feelings	
Skills	

Transformative Learning

In the last decade, Jack Mezirow has developed the "Transformative Learning Theory," the roots of which are in Constructivism. The theory focuses on critical reflection and has a background based on the work of John Dewey who in the first half of the century had identified reflective thinking as a goal of education. Mezirow stated that the "Transformation Learning Theory" grows out of the cognitive revolution in psychology and psychotherapy. It was instigated by scores of studies which found that it is not so much what happens to people but how they interpret and explain what happens to them, and that this determines their actions, their hopes, their contentment and emotional well-being, and their performance."

Multiple Intelligence

Multiple Intelligence is based on the theory that each person has a unique cognitive profile. It was Howard Gardner's 1983 book, “Frames of Mind”, that provided the theoretical framework. According to Gardner, intelligence can be broken down into the following forms: Vernal/Linguistic, Logical/Mathematical, Visual/Spatial, Body/Kinesthetic, Music/Rhythmic, Interpersonal and Intrapersonal.

Musical Intelligence: This is the capacity to think in music and the ability to hear patterns, recognize them, remember them, and perhaps manipulate them. People who have a strong musical intelligence do not just remember music easily; they cannot get it out of their minds. Though musical intelligence may not seem as obvious a form of intellect as is mathematical or logical ability, our ability to perform and comprehend musically (from a neurological point of view) appears to work independently from other forms of intelligence.

Bodily-Kinesthetic Intelligence: Bodily kinesthetic intelligence is the capacity to use your whole body or parts of your body (hand, fingers, arms, etc) to solve a problem, make something, or put on some kind of production. The most evident examples are people in athletics or the performing arts, particularly dance or acting. They have a sense of how their bodies act and react in demanding situations.

Logical-Mathematical Intelligence: This intelligence is our ability to mentally process logical problems and equations. Logical-mathematical intelligence often does not require verbal articulation, for we can churn a complex problem in our head, only to articulate it out loud once the problem has been solved. Traditionally, logical-mathematical intelligence was considered the “raw intellect” on which Western culture has placed a high premium.

Linguistic Intelligence: Linguistic intelligence is the capacity to use language, one's native language, and perhaps other languages, to express what is in one's mind and to understand other people. Poets really specialize in linguistic intelligence, but any kind of writer, orator, speaker, lawyer, or a person for whom language is an important stock in trade, highlights linguistic intelligence.

Spatial Intelligence: Spatial Intelligence refers to the ability to comprehend shapes and images in three dimensions. Examples include the way a sailor or airplane pilot navigates the large spatial world, or the way a chess player or sculptor represents a more circumscribed spatial world. Spatial intelligence can be used in the arts or in the sciences. If one is spatially intelligent and oriented towards the arts, one is more likely to become a painter or a sculptor or an architect than, say, a musician or a writer. Similarly, certain sciences, like anatomy or topology, emphasize spatial intelligence.
Interpersonal Intelligence: Interpersonal intelligence is the capacity to understand other people. It is an ability we all need, but is at a premium if one is a teacher, clinician, salesperson, or a politician. Anybody who deals with other people has to be skilled in the interpersonal sphere. According to Gardner, interpersonal intelligence is seen in how we “notice distinction among others; in particular, contrasts in their moods, temperaments, motivations and intentions.”

Intrapersonal Intelligence: Intrapersonal intelligence refers to having an understanding of yourself, of knowing who you are, what you can do, what you want to do, how you react to things, which things to avoid, and which things to gravitate toward. A strong intrapersonal intelligence can lead to self-esteem, self-enhancement, and strength of character that can be used to solve internal problems. We are drawn to people who have a good understanding of themselves because these people tend not to screw up and know what they can do.

Curriculum Development

Jon Wiles and Joseph Bondi describe curriculum development as core procedures rather than theoretical guidelines. It is a logical process that begins with clear goals of value preferences. When formalized, these value preferences are referred to as educational philosophies or learning theories. Through analysis, design, implementation, and evaluation, curriculum developers set goals, plan experiences, select contents, and assess outcomes of school programmes.

Curriculum Integration

Curriculum integration is a methodology that links the contents and skills from various disciplines. There are various models of integration that seek to achieve an acceptable degree of interdisciplinary learning. Generally, these models use the language and methodology from more than one discipline and focus on unifying themes, issues, problems, concepts, and experiences. These models help the learner make connections among the individual disciplines.

Service-Learning

Service-learning is the process of integrating volunteer community service combined with active guided reflection into the curriculum to enhance and enrich student learning of course material. It is a method through which citizenship, academic subjects, skills, and values are taught.

THEORIES OF LEARNING AND RELATED ASPECTS
Theories on How People Learn

Constructivism: This is a philosophy of learning founded on the premise that we all construct our own understanding of the world we live in through reflection on our experiences. We use the “rules” and “mental models” we generate in this process to make sense of experience. Learning is the process of adjusting our mental models to accommodate new experiences.

Behaviourism: This is a theory of animal and human learning that focuses only on objectively observable behaviours. It discounts mental activities. Learning is defined as nothing more than the acquisition of new behaviour.

Piaget's Developmental Theory: Jean Piaget developed an influential model of child development and learning based on the idea that the developing child constructs increasingly sophisticated cognitive structures, moving from a few inborn reflexes (such as crying and sucking) to highly complex mental activities. A cognitive structure is a person's internal mental “map”, a scheme or network of concepts for understanding and responding to physical experiences within his or her environment.

Neuroscience: This is the study of the human nervous system, the brain, and the biological basis of consciousness, perception, memory and learning.

Brain-Based Learning: An understanding of learning based on the structure and function of the brain. Learning occurs if the brain is not prohibited from fulfilling its normal processes.

Learning Styles: This is an approach to learning which emphasizes the fact that individuals perceive and process information in very different kinds of ways. It implies that the degree to which individuals learn has much to do with whether the learning experience is geared to their style of learning and whether they are or are not “smart”. In fact, the question is not, “Are you smart?” but rather “How are you smart?”

Multiple Intelligences: This is a theory of human intelligence developed by the psychologist, Howard Gardner, who suggested that there are at least seven distinct ways that different people have of “knowing” and “understanding” the world. Each of these is a distinct “intelligence” or a set of skills that allows the individual to find and resolve genuine problems facing him or her.

Right Brain/Left Brain Thinking: This theory deals with the structure and working of the brain. It suggests that different sides of the brain control different “modes” of thinking and that we all have a preference for one or the other of these modes.

Communities of Practice: It is an approach to understand problems of learning and sees learning as an act of membership in a “community of practice”. It seeks to understand both the structure of those communities and how learning happens in those communities.

Control Theory: William Glasser proposed this theory of motivation, suggesting that behaviour is never caused by response to outside stimuli, but instead, by what we want most at the time, probably one of our basic needs (such as survival, love, power, and freedom).

Types of Curriculum and Needs

Outcome-Based Education (OBE): A method for focusing and organizing all school programmes and instructional efforts around clearly defined outcomes that we want all students to demonstrate when they leave school.

Core Curriculum: A core body of skills, knowledge and abilities that will be taught and mastered by all students.

Whole Language: A philosophy/set of beliefs about curriculum (language, arts and broader or general curriculum) based on recent theory and research on how children acquire oral and written language.

Character Education: The effort to develop “good character” in students through the practice and teaching of moral values and decision-making.

Multi-Culturalism: A curriculum approach based on the belief that varying cultural dynamics are a fourth force (along with psychodynamic, behavioural and humanistic forces) which explains human behaviour. The ability to recognize one's own and others' cultural lenses. It is therefore essential to all other learning and must be taught along with communication and thinking skills as prerequisites to other learning.

Tech-Prep: The most traditional and frequently used definition is “a four-year programme (grades 11–14) that leads to an associate degree or two-year certificate in a specific career field.” It is carried out under articulation agreements and includes a common core of required mathematics, science communicates and technologies that are integrated, applied and sequenced.

Paideia: An "essentialist" curriculum proposed in 1982 by Mortimer Adler and The Paideia Group. The curriculum is proposed for everyone and is a 12-year course in general and humanistic learning to serve as a foundation for future learning.

How Should Learning Be Designed? (Instruction)

Mastery Learning: The theory of mastery learning is based on the simple belief that all children can learn when provided with conditions that are appropriate for their learning. The instructional strategies associated with mastery learning are designed to put that belief into practice in the classroom.

Cooperative Learning: A set of instructional techniques that require positive interdependence between learners for learning to take place.

Accelerated Learning: A comprehensive approach to changes in school that started in 1986 at Stanford University. The main objective is to create schooling success for all students by closing the achievement gap between at-risk and the mainstream students. The strategy is to make radical change in individual school by redesigning and integrating curricular, instructional and organizational practices, so that they provide enrichment and not just remediation for at-risk students. It is assumed that at-risk students have "learning gaps" in areas valued by schools and mainstream economic and social institutions, and that remedial approaches have failed to close the gaps because they neither build on students' strengths nor tap into the resources of teachers, parents and the community.

Thematic Instruction: The organization of curriculum around macro "themes" that integrate basic disciplines such as reading, mathematics and science with a broad subject such as communities, rain forests, river basins, use of energy, etc.

Whole-Brain Teaching: An instructional approach derived from neurolinguistic descriptions of the functions of the left and right hemispheres of the brain.

Service Learning: This is aimed at combining community service with out-of-classroom learning. Schools are looking to implement service learning along the entire continuum of K-12.

Cognitive Coaching: A method of instruction based on the understanding that metacognition (being aware of thinking processes) fosters independence in learning by providing personal insights into one's own thinking. It builds confidence to problem solving and encourages self-efficacy and pride.

School-To-Work: The focus of school-to-work programmes is to provide ways for students in schools to successfully obtain either paid employment with a business or be self-employed. Many studies have shown that graduates of high schools not bound for colleges are neither prepared for nor connected to opportunities for employment.

Instructional Technology: The use of technology (computer, compact disc, interactive media, modem, satellite, teleconferencing, etc.) to support learning.

Youth Apprenticeship: A learning system where students become prepared for work by combining classroom instruction with pay on the job training. Students learn theories in the classroom and learn applications in a work setting to obtain a set of well-defined occupational competencies.

How Do We Know If Learning Has Occurred? (Assessment)

Authentic Assessment: An assessment method growing from the conviction that outcomes that matter are too complex to be measured effectively by testing isolated components. Rather, these testing techniques aim to provide proxies of the real problem-solving situations in which students demonstrate global application of relevant component skills and knowledge.

Classroom Assessment Techniques: The use of a variety of feedback and discussion techniques in the classroom to assess the quality of the learning process. Also referred to as "Classroom Research" or "Action Research."

Portfolio Assessment: The purpose of portfolio assessment is to provide a "body of student work" that can be used to appraise student performance over time.

Behavioural Approach: Human behaviour is learned, thus, all behaviours can be unlearned and new behaviours learned in its place. Behaviourism is concerned primarily with the observable and measurable aspects of human behaviour. Behaviourists assume that only things that are real (or at least worth studying) are the things we can see and observe. We cannot see the mind, the idea, or the unconscious, but we can see how people act, react and behave. From behaviours, we may be able to make inferences about the minds and the brain, but they are not the primary focus of the investigation. What people do, not what they think or feel, is the object of the study.

Cognitive Approach: Cognition refers to mental activities, including thinking, remembering, learning and using language. When we apply a cognitive approach to learning and teaching, we focus on the understanding of information and concepts. If we are able to understand the connections between break-down information of concepts and rebuild them with logical connections, then our retention of material and understanding will increase. Researchers who contributed significantly to the development of cognitive psychology include Jerome Bruner, who developed a learning theory based upon categorization, and David Ausubel, who attempted to explain meaningful verbal learning as a phenomenon of consciousness rather than of behaviour.

Humanistic Approach: Humanistic psychology is a psychological perspective that emphasizes the study of the whole person. Humanistic psychologists believe that an individual's behavior is connected to his inner feelings and self-image. Unlike the behaviourists, humanists believe that humans are not solely the products of their environment. They study human meanings, understanding, and experiences involved in growing, teaching, and learning. They emphasize characteristics that are shared by all human beings, such as, love, grief, caring, and self-worth.

ISSUES CONFRONTING CURRICULUM CHANGES IN EDUCATION/INSTITUTIONS

Currently, there are a number of issues confronting curriculum changes in educational institutions. These range from lack of appreciation for improvements to the need of strong leadership quality. More specifically, the critical issues include the following:

- Lack of vision, clear goals, and/or commitment.
- Inadequate attention to the design and methodologies.
- Inadequate knowledge and skills of those who design and use the curriculum.
- Rigid and inflexible evaluation system.
- Adopting quick and easy modes.

WHAT SHOULD BE DONE?

There is growing concern that something must be done to make significant improvements to the existing curriculum and the education process. Various suggestions have been put forth. The main consensus on what needs to be done have included the following:

- Review the national educational policies and reprioritize the crucial and relevant issues in relation to local contexts.
- Expose leader to curriculum design, methodologies and assessment.
- Provide training for leaders in strategic planning, leadership, change management and supporting systems.
- Provide hands-on training for teachers in the design, implementation and assessment of the curriculum with up-to-date methodologies.
- Involve learners, community, public and the private sectors in the process.

As pointed out earlier, some organizations have recognized the need to make the necessary changes and have begun to initiate and undertake the required programme activities towards achieving such an objective. One example is the current IPM programme of the Thai Education Foundation. It has a distinct curriculum framework (see below) quite unlike that usually found in traditional agricultural training in colleges and the universities.

Weekly Training of Teachers Curriculum Framework

Week	Topics/activities
	• Purpose, objectives, training plan
	• Training curriculum
	• Group process
1	• Introduction to ecosystem
	• Seeds and seeds preparation
	• What's this activity? (Learning methods)
	• Observation skills
	• Plant morphology: Seedling stage
	• Living soil and management
	• Weeds
2	• Group process
	• Sampling
	• Learning methods
	• Learning sessions design
	• Learning assessment
	• Plant morphology: budding
	• Nutrition of plants
	• Insect classification
3	• Living water and management
	• Weed management and weed collection
	• Facilitation skills (posing questions)
	• Agroecosystem analysis (AESA)
	• Plant morphology: vegetative stage
	• Insect pests
	• Fertilizers
	• Soils
4	• Animal pests
	• Diseases
	• Learning session designs
	• Facilitation skills (active participation)
	• Learning cycle

5	• Plant physiology and morphology: flowering stage • Natural enemies • Diseases • AESA • Learning session designs
6	• Facilitation skills • Living soil/Living water (continued) • Plant morphology: milky stage • Agrochemicals • Natural enemies (predators) • Learning session designs • Curriculum development • Learning assessment
7	• Summary of plant morphology • Summary of ecosystems survey and analysis • Summary of studies • Summary of learning programmes • Plan for next term • Exhibition day

Weekly Training Calendar & Topics

Time	Monday	Tuesday	Wednesday	Thursday	Friday
AM	***Field activities***				
	Rice Morphology + Special Topic	AESA *	Studies & Experiments	Learning Process & Methodology	Curriculum Work
PM	***Report findings*** ↓				
	Group Process & Training Skills	Special Topics	Experiments	Training Skills	Weekly Summary & Planning

* AESA = Agroecosystem Analysis

To date, the Thai Education Foundation has already devoted much efforts in carrying out a number of diverse programmes, as indicated below:

- Ecology of rice and vegetables (School IPM Programme) for 43 primary and lower secondary schools in 4 provinces.
- IPM courses for the out-of-school young adults and adult farmers on NFE in 35 provinces.
- Field-testing the IPM courses in Chiangrai Agricultural College with preparation for piloting in 4 colleges.
- Preparation for accreditation of the teachers and leadership development with the Universities and the National Education Legislature.

The approach and methodologies used in the programmes have proven to be both motivational and highly effective. Trainee participants have greatly increased their learning, become empowered with the knowledge gained, and have developed the needed confidence to undertake effectively the tasks expected of them. In the future, it is expected that such programme activities will be expanded further so that more colleges and universities can be involved and many more students will have the opportunity to be exposed to the programmes.

OVERALL SUMMARY AND HIGHLIGHTS

The Expert Consultation, guided by the information gained from the country and other invited presentations and the ensuing discussions, appraised the status and various developing issues pertaining to the subject of Plant Pest Management Curriculum Development (PPMCD) in the region. The following are the overall summary and highlights.

Current Status and Developing Process

All participating countries have some form of Plant Pest Management Curriculum (PPMC). However, they are not uniform for several reasons, such as, unequal priorities accorded to different crops and pests in the different countries, different emphasis given to certain technical aspects due to different levels in development of plant protection science, unequal funding support, unavailability of needed resource expertise, and others.

Broadly, there exist two distinct kinds of PPMC in the region, i.e. university level and non-university level. The former is broad-based and has the goal to produce graduates to meet a wide range of job market while the latter is specific and a specialized training to empower farmers toward improved crop production. Presently, the latter exists only in a few countries in the region and is undertaken mostly by agriculture extension agencies. Because this approach has proven to be highly successful, there is strong interest to expand such a training programme, both within and outside these countries.

Updating and revision of PPMC usually take quite a long time (about seven to more than ten years). This is because the decision to make a change normally depends on large and centralized committees that comprise of senior and very busy officials who can meet only infrequently. Partly because of this, the emerging science and other newer interest areas (e.g. biodiversity, biotechnology, organic agriculture, and others) that have significant impact on plant pest management have not been fully included (or are inadequately addressed), thereby resulting in deficiencies in the existing curriculum.

Areas Needing Emphasis

Integrated Pest Management (IPM) is now the central theme in plant pest management and has good prospect to overcome many concerns of pesticide misuse. Therefore, it is crucial to have a comprehensive treatment of IPM in the curriculum. The topics should cover the basics (e.g. historical development, rationale and principles, management tactics and their strategic application, operational constraints in implementation, others) to the more general issues (e.g. policies, institutional structures, human resource capacity and development, project development and funding, others). Particular attention must be given to the wide-scale implementation and operational strategies, drawing lessons from past failures and recent success cases. The newer approach, using non-formal and self-discovery methodology and involving farmer participatory training and research, should receive key consideration. Because plant pest management deals substantially with field problems, practical work in the field should receive importance and adequate attention. Basically, the formal lectures and laboratory experimental studies will help to build a general knowledge and to provide the specific technical skills needed as backup tools for field decisions and operation. Practical work in the field (20–30%) must supplement these to ensure the graduates will have a practical outlook. The practical field work will enable trainees to experience the realities of pest problems normally faced by growers and will help develop the right kind of graduate with a proper balance of education around plant pest management. It is recognized that no amount of book learning/lectures can replace the benefits from direct and personal learning through self-discovery in hands-on activities in the field. This has been amply demonstrated in many farmer participatory IPM programmes in which are incorporated a high level of practical field activities.

New Aspects for Incorporation

In recent years, there are a number of major developments, both agriculture-related and otherwise. Examples include biotechnology, bioinformatics, and others. For instance, the information age has made available easier and quicker access of plant pest management information through huge and interactive databases captured in compact discs, such as the CABPESTCD, Global Crop Protection Compendium, Arthropod Name Index, AGRIS and others. In addition, various kinds of information relating to plant pest management are now also readily obtainable through the global Internet facilities. Awareness of such facilities and the ability to access them are crucial. All these are known to have significant impact on plant pest management programmes. However, they are currently either lacking or are inadequately addressed in the present PPMC. Hence, there is a need to incorporate or strengthen these aspects in the existing PPMC. Other new developments that need to be also included are subjects on biotechnology, biodiversity and organic agriculture. In addition, there are also more general issues needing inclusions, particularly those that have significant implications to plant pest management. Examples include those relating to globalization and trade agreements, such as that of the World Trade Organization (WTO) and the ASEAN Free Trade Area (AFTA). Furthermore, the action plans of UNCED Agenda 21 and the Convention of Biological Diversity (CBD), and the import regulations under the FAO Code of Conduct for the Import and Release of Exotic Biological Control Agents, are also important areas that cannot be excluded.

Mechanisms for Upgrading Skills Relating to Curriculum Development

The IPM curricula in university and non-university level education have developed independently because of differing broad institutional functions and goals. However, the ultimate target objective is similar, aiming at helping growers to manage pests effectively through IPM. Yet these two groups of institutions generally are insufficiently aware of each other activities. There is urgent need to redress this and also to promote good collaboration so that these institutions can operate more efficiently to achieve the common IPM objective. Among others, an important consideration is to make the university IPM curriculum more field-oriented, participatory and applied in nature, while that of IPM implementing agencies having stronger technical contents. A mechanism to achieve this is through direct exposure of the personnel concerned to relevant activities that will help upgrade the needed skills. Several possibilities to achieve this were discussed and agreed to. These include:

i. out-sourcing of the required expertise (e.g. extension specialists from an IPM implementing agency with practical field experience) to help run the relevant field training,
ii. attachment of students with extension specialists in their field programmes, and
iii. in-service training for academic staff in specialized courses or short-term staff exchange exercises between institutions (both local and regional).

Follow-up Activities

Many universities in the Asia-Pacific region offer instructions in plant pest management. However, great variation exists in the course curricula being followed in the different countries. There is need to harmonize the course curricula to better facilitate exchange of students (and also experts) among the countries. To do so, a standard and basic structure of the core curriculum (including some optional courses) for plant pest management must first be developed. The universities in the region could then use this output as a guide to develop their respective course curricula, adding on whatever other optional courses according to specific local needs. Over time, it is expected that this process will help steer towards developing a harmonized course curriculum in plant pest management for the region. To initiate this process, participants at the Expert Consultation formed two Work Groups (A and B) to prepare the basic framework of the pest management curricula, one for university level (Group A) and other for farm level IPM implementation (Group B). Both these outputs (by Group A and Group B) are given below at the end of this section. It should be pointed out that these curricula framework serve merely as a guide only and do not contain the details that are normally required in curricula contents.

To develop the detailed curricula for both university and non-university level education that can be acceptable to all concerned, it was agreed that more time would be required to gather additional inputs and to further consult with other plant pest management specialists in IPM implementing agencies and the universities. This would require a specific working group to undertake the task. Although the group would need to proceed initially with developing the PPMC for the undergraduate level in universities, it should subsequently also formulate the course curricula for post-graduate degrees at both the Master and Ph.D levels. This is necessary because many pest management experts are likely to acquire post-graduate training in the future, although few of those completing the Bachelor degree presently have proceeded further to do the post-graduate programmes in plant pest management. For the post-graduate curricula, a deeper treatment of the topics would be needed besides the inclusions of new frontier areas, such as, Genetically Modified Organisms (GMO), molecular techniques, biodiversity, biosafety, Pest Risks Analysis (PRA), and others.

Since PPMC must be responsive to the ever-changing needs of farmers and the general agriculture industry, a regular review and monitoring of the PPMCD is considered desirable. In this regard, follow-up Consultations may be held to meet such a requirement as and when considered necessary.

OUTPUT OF WORK GROUP A

Proposed Framework of Plant Pest Management Curriculum for University Education in the Asia-Pacific Region

Foundation (75%);
General requirements (20%)

Social Science
Foreign Language
Philosophy
Agriculture Economics
Law
Introductory Management

Natural Science
Computer
Physics
Biology (Botany, Zoology, Microbiology)
Chemistry (Organic, Inorganic)
Mathematics
Statistics
Genetics and Plant Breeding

Specific Courses (55%)
Introductory Agronomy
Meteorology
Soil Science
Plant Physiology
Plant Biochemistry
Introductory Agrobiotechnology
Introductory Entomology
Pests of Crops
Introductory Plant Pathology
Weed Science
Vertebrate Pests
Pesticide Management
Plant Quarantine
Epidemiology of Plant Diseases
Pest Forecasting and Crop Loss Assessment
Integrated Pest Management (IPM)
Biological Control of Pests
Ecology of Crop Pests
Extension of Agriculture Technology
Agriculture Machinery in Plant Protection
Seminars
Special Topics
Practical Work

Elective Courses (25%)
Insect Morphology and Physiology
Insect Taxonomy
Insect Pathology
Agriculture Acarology
Beneficial Insects
Urban Insects
Application of Computer in Plant Protection
Biological Control of Pests
Breeding for Plant Resistance to Pests
Agriculture Environmental Protection
Organic Farming
Diagnosis of Plant Diseases
Epidemiology of Plant Diseases
Post-Harvest Pests and Diseases

Remarks
1. The primary degree is a 4-year (8 semesters) academic programme.
2. Most of the courses on social science and natural science should be taken in the first and second year, while the specific and elective courses are to be taken in the third and fourth year.
3. The practical would include field experiments and other field activities in Plant Pest Management.
4. Special Topics refer to current/hot issues in Plant Pest Management.

OUTPUT OF WORK GROUP B

Plant Pest Management Curriculum for Farm-Level IPM Implementation

1. Work Group recommendations

Work Group B recognizes that farmers learn by experimenting, make careful observations and comparisons, identify and prioritize what they want to learn, discover and re-discover, and carry out analysis so as to make informed decisions. Guided by this, it makes the following recommendations:

- Integrate more field-based activities (e.g. learning from farmers, carrying out studies in farmers' fields) into the university curriculum.
- Include facilitation/learning methodologies in the university curriculum to help students work with farmers.
- Expose students to field implementation of IPM by visiting existing field activities or/and invite IPM implementers from successful programmes (e.g. FAO Programme on Community IPM in Asia) to share their experiences on field IPM implementation.

2. Characteristics of IPM/plant pest management training at farmer level

How do farmers learn?	How to organize farmers?	What?
• Experiments	• Baseline surveys-crop calendar	Pests
• Comparison	• Identify key leaders	Natural enemies
• Identify what they want to know and prioritize	• Focus on problems faced by farmers	• Crop loss assessment
• Observation	• What do farmers know?	• Seeds/varieties-land preparation
• Analysis	• Learning contract	• Chemical inputs
• Discovery		• Post harvest
• Decision making process to enable farmers to make informed decisions		• Fertilizers

3. Example of Course Guide on Rice Farmer Field School (FFS)

(i). *Objectives*

By the end of the FFS, the participants should be able to carry out the following:

- Describe the development of the crop.
- Describe plant compensation and give an example of the importance of plant compensation for stemborer, leaf-folder, or disease management.
- Identify the ecological function, life-cycle and give the local names of major insect detritivors, insect pests and natural enemies seen in the rice field.
- Identify the local names and development factors of major diseases found causing yield losses in the field (if they exist).
- Identify rat damage, and rat habitat where appropriate.
- Describe snail growth, development, and ecological habits.
- Describe the toxicity of commonly used pesticides (herbicides, fungicides, insecticides, rodenticides, and molluscicides) and methods to avoid exposure to pesticides.
- Describe the effect of pesticides (herbicides, fungicides, insecticides, rodenticides, and molluscicides) on target pests, natural enemies, non-target pests, the environment and health of farmers and consumers.

- Describe the level of potential yield-loss given a particular field condition and compare with the cost of controlling the yield-loss factors (decision making).
- Describe the potential development of pests in the given field conditions (plant development and stage, weather pattern, plant resistance, water levels, pests, natural enemies, etc.). Compare this to the potential management costs for activities (irrigation, fertilization, pest control practices) that may be undertaken to improve yields and reduce impact of yield-loss components (decision making).

(ii). _Farmer Field School Activities_

The FFS is typically 10 to 14 weeks in length. The first session begins with transplanting or broadcasting and continues until harvest. The sessions are best held weekly (if beginning with transplanting), or less than weekly (if in direct seeded areas). Each session begins in the morning and ends before lunch (one half day). The typical contents of the FFS are listed below. The FFS participants may want to alter this schedule to focus on particular local issues.

<u>Season-long Studies</u>

a. *IPM and farmer practice comparison trial:* This trial is conducted on a 1000 m^2 plot supported by the FFS. 500 m^2 is used for the IPM field, and 500 m^2 is used for the "Farmer Practice" field. This 1000 m^2 field plot is used as the "Study Field" for the FFS. All other activities are also conducted in this field.
b. *Field trials:* The classical IPM studies on "Stemborer plant compensation simulation", "Defoliator plant compensation simulation", "Nitrogen efficiency including organic materials and impact of pests", "Seed production", or other studies, can be conducted in the field. Usually one or two of these studies are undertaken by the FFS depending on the major issues encountered by the FFS participants.

<u>Topics on Specific Field Guide Activities</u>

These are carried out in the field or adjacent to the field and covering aspects relating to IPM and Group Development.

(iii). _Weekly Schedule_

The following weekly schedule is a sample from a 12-week FFS. In general, it will be necessary to adjust the contents and schedule to local conditions, field problems and farmer interests.

Pre-Season:	Prepare seed-bed and seedlings for 1000 m^2 to be ready in time for the first FFS session. Meet with farmers in the FFS area to explain the FFS and to recruit participants. Be sure to clarify all obligations of FFS participation. Arrange for a 1000 m^2 "Study Field" within easy reach of the FFS participants. Compensation should be provided to the owner of the land.
Week 1:	Opening ceremony with introductions, Ballot-box pre-test and planting of "Study Field" by FFS participants and trainers.
Week 2:	Drawing together (team building). Ecosystem Agro-Ecosystem Analysis (decision making).
Week 3:	"San Luis" Predators
Week 4:	Agro-Ecosystem Analysis (decision making).

	"Broken Squares" Roots/Vessels & Pesticides Agro-Ecosystem Analysis (decision making).
Week 5:	"Balloons" Primordium Development and Fertilization Agro-Ecosystem Analysis (decision making).
Week 6:	"Making Sate" (group dynamics). Reduced Exposure to Pesticides & Pesticide Toxicity. Agro-Ecosystem Analysis (decision making).
Week 7:	Group Dynamics. Rats or other topic Agro-Ecosystem Analysis (decision making).
Week 8:	Brainstorming on follow-up activities. Diseases or other topic. Agro-Ecosystem Analysis (decision making).
Week 9:	Being a Natural Enemy. Life cycles: Parasitoids, Stemborers, and Leaf-folders. Agro-Ecosystem Analysis (decision making).
Week 10:	Proposal Writing, Workplans, Budget Community Self-Survey Agro-Ecosystem Analysis (decision making).
Week 11:	Field Day Planning Seed Selection or other Topic. Post-test
Week 12:	Field Day/Harvest and Weighing of Field Trials. Closing Ceremony with Certificates.
Post-FFS:	Inform FFS participants of pre- and post-test scores. Make regular visits to follow-up activities.

RECOMMENDATIONS

The Expert Consultation noted that almost all countries in the Asia-Pacific region have universities and/or related institutes of higher learning with Plant Pest Management Curriculum (PPMC). It also noted that many of the curricula are dissimilar and that these dissimilarities are due in part to unequal priorities accorded to different crop and pest problems, different emphasis given to different technical aspects of plant protection science, unequal allocations of funding support, and different levels of resource capability. The Consultation, convinced that a uniform curriculum will help produce graduates who can take equal advantage of the advances made in plant pest management in the region, therefore recommended that ways and means be developed to reduce such differences in the present PPMC. It also recommended that improvement be made to the teaching methodology of plant pest management at the university level so that graduates can become better equipped to implement effectively farm-level IPM (or Integrated Pest Management) and that large-scale IPM implementation can be successfully achieved in the countries of the region.

In the above context, the Consultation encouraged forming a separate Working Group to discuss in greater depth the issues raised during the Consultation. This Working Group should include members from the academics as well as field implementers with a view to enhance collaboration between teachers and field workers. Such collaboration would ensure effective feedback from the field to support the development of a more practical PPMC. The Consultation therefore recommended the formation of the "Asia-Pacific Working Group on Plant Pest Management Curriculum Development" with the structure and responsibilities as outlined below at the end this section. This Working Group will need to also work between Consultations should more of the latter be considered desirable subsequently.

The Consultation noted that university faculty development should be an important item in the FAO IPM activities, especially for IPM trainers. This may take the form of regular refresher training that should be organized with a view to upgrade skills and knowledge of faculty members. Such refresher training should be carried out in close cooperation with field trainers who have enormous practical field experience and who have made significant advances in the implementation of IPM, e.g. those who have been involved with IPM of rice and vegetables.

The Consultation also noted that there is a need for university faculty members to interact with other resource persons (especially in-country expertise) from all sectors of IPM stakeholders (including agribusiness, others). These resource persons should be encouraged to share their knowledge with faculty members who are involved in plant pest management teaching to provide a more holistic view of the subject.

In addition, the Consultation called for the strengthening of a two-way flow (including collaboration) between universities/research institutes and the farming community. The Consultation recognized that there is often a breakdown between research/teaching and field implementation of plant pest management. To minimize this, the Consultation called for strengthening of the linkages between universities/research institutes and the implementing agencies.

The Consultation noted that the above process of strengthening linkages between the field and classrooms will help produce well-rounded students imbued with facilitating/learning/communicating skills capable and confident in working with farmers.

The Consultation appreciated that farmers often have field experiences based on traditional practices. Therefore, PPMC developers should recognize their potential contributions and should encourage the scientific evaluation of their practices, as part of a research programme to better understand farmers and their pest management practices.

The Consultation agreed that universities should be encouraged to carry out specialized studies in any field of plant pest management and become centres of excellence in the selected fields of studies. The Consultation further agreed that such effort will help strengthen both the curriculum development and networking among universities.

The Consultation noted that many PPMC have not taken note of emerging issues. Hence, the Consultation recommended that there be constant monitoring and review of the existing PPMC in the universities with a view to provide timely upgrades. This is of particular concern as there are rapid advances in IPM in the region.

The Consultation was concerned that revised PPMC often takes a long time to be implemented. Therefore, the Consultation called for efforts to speed up the adoption of any revised curriculum to take advantage of the rapid development in certain topics or fields of studies (e.g. biotechnology, bioinformatics, biodiversity, others).

To encourage co-operation and collaboration between universities in the region, the Consultation urged universities and related institutions with PPMC to place these on the Internet to ensure a wider circulation.

Noting that plant pest management is an important field of plant production and that new advances and developments do emerge from time to time, the Consultation recommended that holding future Consultations be given consideration whenever necessary. Besides other activities, future Consultations could review the progress and achievements of the Working Group, consider possible networking, and develop other follow-up activities.

Activities:

1. Set up a national group/committee on PPMCD to identify national needs on development of plant pest management.
2. The WG will examine the existing curricula and courses of various degree programmes of plant pest management and allied sciences and suggest a standard curriculum taking into account:
    a. subject already covered at pre-university level.
    b. ensure emphasis on practical content so as to develop adequate confidence in the minds of graduates for extension activities and self-employment.
3. The WG will suggest guidelines for formulation of post-graduate programmes in terms of course contents (major and minor, research, etc.)
4. Develop co-operative programmes to bridge the gap in areas identified by the national committee/body.
5. Collect, collate and disseminate information on PPMC, courses, and educational development, among the member/co-operating universities and related institutions.
6. Prepare a directory of universities and related institutes conducting plant pest management/plant protection courses in the region.
7. Organize national meetings and workshops/seminars on PPMCD issues. The reports should be transmitted to the WG secretariat at FAO-RAP, Bangkok.
8. Follow up on the recommendations and report to the WG secretariat.

9. Periodic reports to the WG secretariat regarding contributions and overall role of regional and related international organizations/agencies in curriculum development.

ASIA-PACIFIC WORKING GROUP ON PLANT PEST MANAGEMENT CURRICULUM DEVELOPMENT

Scope:	The Working Group (WG) will cover the disciplines and activities relating to Plant Pest Management Curriculum Development (PPMCD) for university and related institute education and its follow-up extension	
Objective:	To assist the participating agricultural universities and related institutes of the Asia-Pacific region in the development of Plant Pest Management Curriculum (PPMC), exchange of expertise, and student attachment/visit for specialized training in selected institution.	
Structure:	Chairperson	Dr. S. N. Puri (India)
	Vice-chairpersons	Dr. Chitapa Ketavan (Thailand) - for university level curriculum Dr. Peter A. C. Ooi (FAO IPM Regional Project) - for farm level farmer participatory curriculum
	Members	Prof. Wang Hui-Min (China) Dr. Edhi Martono (Indonesia) Mr. Yazid Mohd. Esa (Malaysia) Ms. Wilma R. Cuaterno (Philippines) Dr. Surachate Jamormarn (Thailand) Prof. C. Y. Shen
	Secretariat	Regional Plant Protection Officer FAO Regional Office for Asia and the Pacific Maliwan Mansion, Phra Atit Road Bangkok 10200, THAILAND

(**Note**: *The membership of the WG shall be open to the national and private universities, related institutes, and relevant government agencies involved in agricultural development in member countries*).

Initial Activities and Expected Outputs of Working Group

ACTIVITY	OUTPUT	TIME FRAME	ACTION BY:
To formulate IPM curriculum module and curricula for Bachelor degrees (IPM and other related plant pest management degree streams)			
Request WG members to collate plant pest management curricula in their respective countries.	Various plant pest management curricula from local universities and other related institutes collated by WG members.	July 2000	Chairperson
Peter Ooi to initiate gathering relevant information of past on-farm IPM training (e.g. curriculum content, contacts of trainees,	Information of conducted training programmes and the trainees.	July 2000	Vice-Chairperson (on-farm IPM curriculum)

current job function, etc).			
Local PPMC compiled and sent to Chairperson.	Comprehensive country PPMC compiled.	September 2000	WG members
Information of past on-farm IPM training compiled and sent to Chairperson with suggestions on how they may be incorporated into the university IPM curriculum.	Information of on-farm IPM available.	September 2000	Vice-Chairperson (on-farm IPM curriculum)
Draft module on IPM curriculum (suitable for use in different related streams of Bachelor degree) prepared and sent to WG members and Vice Chairpersons (Chitapa and Peter Ooi) for comments.	Draft IPM curriculum module	November 2000	Chairperson
Feedback/comments provided to Chairperson by WG members and Vice-Chairpersons.	Improved draft IPM curriculum module	December 2000	WG members and Vice-Chairpersons
To finalize the IPM curriculum module taking into consideration the feedback. Send final version to WG members and FAO-RAP.	IPM curriculum module (final version)	February 2001	Chairperson
Make arrangement to place the IPM curriculum module in website of FAO-RAP and the relevant universities and related institutes.	IPM curriculum module in website	March 2001	FAO-RAP, Chairperson, Vice-Chairpersons, WG members, relevant universities and related institutes.
FAO-RAP to inform member countries of the IPM curriculum module and to request relevant feedback.	IPM curriculum module available to member countries.	April 2001	FAO-RAP
Feedback obtained by FAO-RAP from member countries.	Various feedback on the IPM curriculum module from member countries.	June 2001	Member countries
FAO-RAP compiled feedback and sent to Chairperson.	Compilation of feedback on the IPM curriculum module from countries.	July 2001	FAO-RAP
Chairperson appraised feedback and related issues with Vice-Chairpersons and WG members and prepare the country feedback appraisal report.	Report on country feedback.	September 2001	Chairperson, Vice-Chairpersons and WG members
To formulate plant pest management curricula for higher degrees (Master and Ph. D)			
Initiate the development of PPMC for higher degrees with Vice-Chairpersons and WG members.	Various higher degree curricula on plant pest management.	May 2001	Chairperson
Process/develop higher degree curricula.	Various higher degree curricula on plant pest management gathered and processed.	July 2001	WG members, Vice-Chairpersons and Chairperson
Finalize draft of higher degree curricula and submit to FAO-RAP.	Draft plant pest management curricula for higher degrees	September 2001	Chairperson

PPMCD WG Meeting/Consultation Objectives: -Review work progress of WG. -FAO-RAP to report member country feedback on Bachelor degree IPM curriculum module. -Appraise status of curriculum adoption and identify constraints. -Progress/finalize draft curricula for higher degrees. -Plan future activities of WG. -Other related matters that may arise.	Report of WG Meeting/Consultation (and recommendations).	October 2001 or other suitable time after.	FAO-RAP

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