GCP/SIL/032 GER

SEED PRODUCTION AND TRIANING MANUAL

FAO/GERMANY COOPERATIVE PROGRAMME
For
MINISTRY OF AGRICULTURE, FORESTRY AND FOOD SECURITY

Federal Ministry
of Food, Agriculture and
Consumer Protection

LAMBERT
DELIMINI

10/16/2012

SEED PRODUCTION AND TRIANING MANUAL

TABLES

PREFACE

Plant breeding activities lead to the development and release of improved crop varieties. The purpose of releasing improved crop varieties is to increase productivity and overall crop production to anchor food security. Food security is achievable through mass utilization of varieties which are high yielding, resistant/tolerant to pests and disease pressures, ecologically suitable, tolerance to drought and soil mineral toxicity. To further the goal of varietal releases, farmers must have access to and benefits from the use of varieties through agricultural intensification where improved seed is backed by good agronomy, fertilizers and pesticides application under conservation agriculture.

Dissemination of improved crop varieties to famers under the formal sector is generally channeled through seed systems, institutions and agencies. There are different types of seed development and certification systems the choice of which may depend on national agricultural and seed policies, level of development of the national seed industry and the financial status of farmers. Each system has its goals and objectives to accomplish. The different seed systems vary from seed projects, parastatal organizations, private companies, to public/private/partnership enterprises. Each level depends on the national agricultural development agenda and the objectives to achieve.

The Government of the Republic of Sierra Leone, in collaboration with the Republic of Germany embarked on seed industry initiatives about 30 years ago, with the establishment of a Seed Multiplication Project to ensure the development and dissemination of improved quality rice seed to farmers. This evolved into a Seed Multiplication Unit. The focus at that time was to ensure the availability of improved high quality rice seed to farmers. With the advent of the dreadful war in the 1990s, operations of the unit were interrupted leading to a complete collapse of the activities of the unit. As a consequence, seed of all kinds was scarce and rice seed in particular which is a major staple food of the country was unavailable.

To accelerate the realization of food security, the GOSL has restructured the national seed industry with a private/public/partnership enterprise engagement in the seed delivery apparatus as an option. The public/private/partnership option is to engender competition among seed enterprises in the seed sector, for a more efficient delivery of a wider range of improved crop varieties and planting materials. The final goal is to eventually develop a seed system which will be self sustaining, profitable and capable of delivering the right type of seed at a competitive price. Apart from the Seed Multiplication Program (SMP), which is being nurtured by the Government of Sierra Leone and the Food and Agriculture Organization of the United Nations (FAO) through the Seed Enterprises

Enhancement and Development (SEED) Project, there are now, other seed enterprises, some of which are supported by other Programs and Projects such as the Program for Agricultural Seed Systems(PASS) and the Agricultural Revolution for Africa (AGRA) To maximize profitability and services of seed enterprises to farmers and seed users, some of the enterprises have now expanded their product lines to include other crops such as maize, cassava, beans and sweet potatoes.

To achieve the objective of providing quality seeds to farmers, requires capacity building in seed production technology, marketing, business management and other elements that require the involvement of key stakeholders and strategic partners. Capacity building in the seed production component, covers common staple cereal crops and pulses such as rice, maize, beans and groundnuts. It also includes the staple vegetative planting materials such as cassava and potatoes. The purpose of the manual is to serve as a reference training manual for technical staff, seed producers and a contribution to the development and progress of the seed industry in Sierra Leone especially with the private sector in view. It is also in partial fulfillment of the TOR of the seed production consultant.

CHAPTER ONE: SEED PRODUCTION OF SELECTED CEREALS AND PULSES

1.1 Introduction:

Rice is the most important staple crop in Sierra Leone. It is consumed by approximately 90% of the population and per capita consumption is estimated at 80kg per person annually. It is grown extensively under five major ecologies, which are upland, mangrove swamp, inland swamp, riverain grass land and boliland. Upland rice is grown throughout the country. Rice production in inland valley swamps is widely dispersed also, but the production of mangrove swamp rice, riverain grassland and boliland is restricted to fairly well define ecological areas of Sierra Leone.

.

Rice research in Sierra Leone began in the 1950s and by the close of the 1970s a considerable number of rice varieties mainly of the ROK series had been released by the Rice Research Institute at Rokupr, now the SLARI, for the various ecologies. Some of the varieties released over the years are accompanied by technical/passport data, to aid in the selection of suitable varieties for the various ecologies.

Activities in rice research and crop improvement slowed down in the recent past, partly for inadequate funding, but to a large extent due to the traumatic, protracted war which destroyed almost all the infrastructure for rice research. This stagnated research programs rice crop improvement and release of rice varieties with the result that most of the Rok varieties became contaminated with other varieties, and some of them lost in the seed production chain. Attempts are now being made to purify some of the Rok varieties, and also release new ones especially those of the Nerica series. Current varieties under maintenance breeding for seed multiplication are Rok5, Rok10, Rok14 and Rok24. Due to the slow pace in rice varietal purification and releases, the seed program under the SMP, has embarked on improving seed quality through maintenance breeding and intensive panicle selection. With the support of AGRA and other international donor agencies, SLARI has also intensified efforts to quicken the pace of rice research, to release new varieties of rice, cowpea, cassava and sweet potatoes. In the case of rice, the emphasis has been on the Nerica series, developed by WARDA under the Africa Rice Program.

The restructuring of the national seed program in Sierra Leone has added another dimension to the seed delivery system. New entrants have now joined the seed distribution network, and this entails competition and an improvement in seed quality. To fulfill this need it has become imperative for SLARI to introduce new and high yielding varieties into the seed multiplication system. As the national research institution, SLARI has the mandate for this function.

However as mentioned earlier, due to the slow pace in the crop improvement and release processes in SLARI, the SMP, one of the commercial entities created under MAFFS, was supported by the SEED project of FAO, to import new varieties from the Savannah Agricultural Research Institute in Ghana, to augment the current Rok varieties under purification at the maintenance multiplication site in Thakoblor. Clearance was given by MAFFS and the varieties imported are as follows: Jasmine a medium duration variety and suitable for upland ecology, Digan a short duration variety suitable for low and upland ecologies and Nerica 3, short duration and upland ecology. Nerica 3, is already available in the country. It is envisaged that these varieties will occupy some space in the seed delivery system for some time, synchronized and mainstreamed into the rice research program of SLARI in future.

1.2 Rice Seed Production:

Rice (Oryza sativa) is a self pollinating crop with both the male and female reproductive organs residing in the same flower but located differently. As a self pollinating crop, the pollen produced by the plant fertilizes itself. In seed production, an understanding of the mode of pollination and fertilization in plants is of utmost importance. There are three methods of planting rice seed in Sierra Leone. The seed can be nursed before transplanting, sown directly by broadcasting or drilling. If the seed is broadcast the seeding rate is normally much higher than when nursed or drilled. For all the three methods, achievement of quality control standards, follow the same control measures, procedures and methods.

However, with the practice of nursing before the seedling is transplanted, a lot more attention and care are given to the agronomy of seed nursing and nursery management in order to meet acceptable quality control standards. Field trials have also shown that, seeding rates are lower and crop yields are higher when the rice is nursed before transplanting. Therefore, seed nursing and nursery management are important components of seed production practices in Sierra Leone.

For field inspections and other seed quality control activities basic data of released varieties under production in Sierra Leone and those imported from Ghana are provided below:

Table 1: Basic Characteristics of popular rice varieties grown in Sierra Leone

Variety	Ecology of adaptation	Duration (sowing to maturity) - days	Plant Height at maturity (cm)	Tillering ablility	Lodging	Stem borer/reaction	Yield range (Metric tonnes/Ha
ROK 3	Uplands, Inland valley swamps & Bolilands	140-150	80-120	Fair	Moderately resistant	susceptible	2-3
RoK 5	Mangrove and inland valley swamp	130-155	100-135	Fair	Susceptible	Susceptible	4-5
Rok 10	Tidal and Associated Mangrove & Inland valley swamps, boliland with long lasting water	170-190		Good	Susceptible	Moderately resistant	Very good/ up to 4 tonnes
Rok 14	Inland valley swamp	130-135	80	Very good	Resistant	Moderately resistant	High tielding
Rok 24	Inland valley swamp	160	95-115	Good	Resistant	Fairly resistant	3-3.5
Lac 23	Upland	125-135	125-130	Average	Lodges at higher fertility	Susceptible	3.0-4.0
Nerica l-19	Lowland	105-110		Good	Resistant	Fairly resistant	2-2.5
Pa Kiamp	Uplands/ Bolilands	130-140	120-130	Very good	Resistant	Resistant	3.5-4.5

Source: Sierra Leone Agricultural Research Institute.

Table 2: Varietal Characteristics of the Ghana Varieties

Variety	Ecology of adaptation	Duration (sowing to maturity)	Plant height at maturity	Tillering ability	Lodging	Stem borer reaction	Yield range (Metric tons)/Ha
Jasmin 85 (Gbewaa Rice)	Irrigated/Rainfed/Lowland/Valley bottom	110-115 days	110 cm	Good	Resistant/tolerant	Resistant/tolerant	5 Ha
Digan (IR12979-24-1-1)	Upland and Inland	100-110 days	115 cm	Good	Resistant/tolerant	Resistant/tolerant	3.5-4 /Ha
Nerica 3	Upland	95-100	110	Good	Resistant/tolerant	Good	2.5-3

CHAPTER TWO: SEED PRODUCTION

2.1 SEED PRODUCTION STARTING WITH SEED NURSERIES

Registration of contract growers and training:

To qualify as a registered seed producer, a farmer must first register and also sign a contract agreement with the seed enterprise. List of registered growers is then forwarded to the Seed Certification Agency for field inspection and certification procedures to be followed. Apart from the registration with the seed enterprise for internal quality control purposes, the contract form is a business agreement signed between the grower and the enterprise. In the case of the SQCU, it is an administrative agreement/procedure for Seed Quality Control measures to be followed at the time of foundation seed purchases to the time of field inspections, harvesting, conditioning, testing and certification. These administrative procedures are first discussed with the grower and the contents explained by the SQCU or the enterprise during training.

Source of seed:

The seed enterprise through research recommends the variety and the class of seed to be multiplied. Seed must be obtained from an authentic source. The contracting seed enterprise will supply the registered seed grower with higher class seed than the class the farmer has been contracted to grow.

Selection of land:

The land/field must meet seed production requirements. For certification purposes, field/land requirements of the enterprise must meet the selection requirements of the SQCU. The land must be ecologically suitable.

The choice of the right nursery site is a prerequisite for proper seedling establishment, reduction in seedling damage and stuck during transplanting.

The land selected for seed production must be fertile, preferably light textured, with adequate irrigation and proper drainage system. The field should be free from weeds and volunteer plants from the previous paddy crop. The field should not be infested with serious pests and diseases.

Isolation/ previous cropping:

The field should be well isolated in accordance with rice seed isolation and previous cropping requirements. Generally as a self pollinating crop isolation is normally not very serious except for inadvertent admixtures. A minimum of about 10meters from another rice field is acceptable. Rice seed should follow a rice crop, only after a minimum of 2years duration.

Land preparation:

There are different ecologies for rice seed cultivation in Sierra Leone. Rice varieties are ecology-specific, and yield best in a specific ecological condition. The nursery area must be properly brushed, and all thrash removed. The area is then ploughed and the beds are raised.

Land preparation must be thorough, to attain the required tilth, to suppress weed growth and enhance moisture retention, easy germination and root penetration. Remember, good land preparation is the starting point for good weed control.

Nursery bed preparation and sowing

Due to the high cost of breeder/foundation seed, it is essential to raise the nursery bed in a well managed field, if healthy and robust seedlings are to be obtained. Optimum seed rate should be applied usually at 40kg/ha and every seed must be utilized by adopting good nursery management practices. A sparse well-managed nursery gives healthy seedlings for the main field. In Sierra Leone two types of nurseries are recommended depending on the site selected; the wet bed nursery and the dry bed nursery.

Types of Nurseries

Wet bed nursery:

This is nursing seeds in swamps within the seed plot where the seedlings are going to be transplanted. How to prepare nursery bed? Look at an area within the seed plot where the water level is the lowest. Construct a bed 1 meter by 4 meters depending on the size of the seed plot. Construct the nursery bed to be at least 5cm above the water level. Remove all stumps and remains of the previous plant roots otherwise these stumps and roots ooze out a solution which has chemicals that are detrimental to the establishment and growth of seedlings. The bed should slope downwards from centre to the edge such that water does not settle in the middle of the bed. After nursery bed preparation leave it for at least 24 hours before sowing the seeds. This type of nursery is ideal for short duration varieties. During transplanting remove the seedlings with a ball of earth in order not to damage the roots and also to aid establishment of the seedlings.

Dry bed nursery

This is usually the practice of nursing seed rice in the upland. This method is only applicable for medium and long duration varieties that can stay up to 28 to 35 days without any significant loss in seedling establishment as well as seedling damage during uprooting and it is mainly practiced at the start of the rains. Short duration varieties should not be do sown in dry bed nursery on the up land for the following reasons:

There is uneven distribution of soil water in the soil and may lead to poor germination or delay germination thereby result in uneven seedling growth.
Germination depends on amount of rainfall or dew that falls during off season or second cropping.
Damage to the roots is very high when seedlings are uprooted. Apart from that, seedlings usually suffer from an initial shock immediately after transplanting before establishment, therefore development may be slowed down during the establishment stage if some of the roots are missing.

Fertilizer application:
Apply basic fertilizer preferably NPK, 15:15:15 which is the recommended NPK fertilizer before nursing/planting.
For nursing purposes, puddle the soil if the field has been used for another rice variety to avoid introduction of volunteer crops which is a source of mixing the variety under seed production; in other words check previous cropping state, to avoid inadvertent admixtures. Dry the seed for 2-3 days to break dormancy and then pre-germinate to be able to determine percentage germination before nursing. After nursing the seed, water the nursery adequately to ensure seeds imbibe enough water to trigger physiological processes to speed up germination. Apply ammonia after germination to speed up growth and root penetration.

Labeling:
Label all nurseries clearly for easy identification; each label should have the necessary information, such as crop spp, variety, class of seed, date nursed etc. This stage also advertises your new variety of rice seed.

Nursery management:
Water as and when necessary.
Remove weeds as early as possible.
Apply Ammonia/Urea when seeds germinate.
Control rodents, insect pests and other animals.
Apply insecticides as necessary.

Transplanting:
During transplanting, adhere to field inspection regulations of isolation distances and previous cropping requirements. If transplanting is to be done on old irrigated fields, the fields must be properly pulverized to effectively destroy weeds and any volunteer plants. Flood the field for about twenty four hours. Drain field for about a day before transplanting the seedlings. This allows seedlings to be firmly established before field is flooded again.

Transplanting is done when the nursery crop is about 25-30 days old. When seedlings are transplanted at a very young stage there is a delay in flowering. Equally, when the seedlings are transplanted at a very old stage, there is accelerated flowering. In both cases the tillering capacity of the crop is reduced. Therefore transplant at optimum time of 25-30 days after nursing.
Before transplanting, the seed plot should be properly pulverized and evenly leveled so as to allow even water distribution and to keep fertilizers applied within the seed plot.

Uproot seedling by using a spade or cutlass. Remove seedlings gently with a ball of earth around the roots. Transplant with the ball of earth at least 1 to3 seedlings per hill with a spacing of 20cm by 15cm. This will reduce shock and allow easy seedling establishment in the seed plot. Tiller formation is enhanced when seedlings are transplanted at the rate of 2-3 seedlings per hill/stand to enhance good tiller formation.
Where there is ample evidence of presence of iron toxicity, construct drainages to drain water before transplanting.

Fertilizer Application:
Apply basic fertilizer preferably NPK (15:15:15) at recommended rate of 270kg/ha i.e. about 100kg NPK/acre and 50kg urea/ acre.

Field labeling:
Ensure all fields are properly labeled, for easy identification of crop sp and varieties. Good labeling also serves as another form of advertisement of crop varieties and facilitates field inspections.
Data on label: Crop sp; variety; class of seed; date transplanted etc

Weed control:
Two types of weed control measures are available: manual weeding 2-3 times depending on weed situation and or use of chemical weed control/herbicide. Choice depends on farmer and resources. Two types of chemical control measures are available; post emergence and pre-emergence. At pre-emergence herbicide is applied before or immediately after planting. For post emergence the herbicide is applied after the crop/weeds have germinated.
For hand weeding, two weeding are recommended.
First weeding to be carried out when crop is 14-21 days old.
Second weeding is carried out when crop is 35-42 days old.

Water control:

Rice is a water loving crop and does well when water is available through its growth cycle. Effective water control engenders high yields. It is useful to erect peripheral bunds around rice plots, to control water by facilitating regular drainage and impounding of water. Poor water control resulting in long water impairs early tiller formation, though encourages late tiller formation and increased number per hill. Prolonged standing

Field inspection:

Field inspection is critically important in rice seed production. It provides the best opportunity to observe and measure the quality of plants which produce the seed. This is done by observing the parent plants in the field. Seed fields are inspected to ensure that the seed fields are genetically, physically and pathologically pure within the limits of field quality standards required by law or established by the production program.

field inspections are normally conducted at the planting, crop growth to ensure good ng water also delays harvesting, causes lodging especially at the ripening stage.

crop stand, proper rouging is carried out and diseased and pest infested plants removed. Field must be properly rogued, weeded and fertilized for good grain filling and optimum yields.

2.2 RULES FOR CERTIFYING RICE SEED (SELF POLLINATION CROP)

Classes of Seed:- The four classes of seed recognized for the purpose of seed certification are Breeder/Pre-basic, Basic/Foundation, Certified1 /Registered and Certified 2.

Land Requirements:

Field offered for certification must not have grown rice for the previous two years unless-

(a) The rice grown on the land previously was of the same variety and class as the one being offered for certification.

(b) The rice grown on the land previously was field inspected and approved for varietal purity.

Field Inspection

(i) Each field offered for certification shall be inspected at the time of flowering.

(ii) Restriction on Number of Varieties:-

Only 1 variety can be grown per field, unless otherwise specially approved by the certifying authority.

Field Standards-

(i) Isolation- Fields for certification shall be at least 5 m from fields of different varieties if field is not bunded.

(ii) Maximum permitted in each class:

Table 3: Field Standards

Seed class	**Breeder**	**Foundation**	**Registered**	**Certified**
Other varieties	Nil	Nil	Nil	1/1000
Red rice	Nil	Nil	Nil	1/100000Seed borne dis
Seed borne disease	Nil	Nil	Nil	1/1000
Objectionable/noxious weed	Nil	Nil	Nil	Nil

Table 4: Seed Standards

Factor	**Breeder**	**Foundation**	**Registered**	**Certified**
% Varietal purity	99.9	99.9	99.7	99.7
% Specific purity	98	98	98	98
Germination %	80	80	80	80
Moisture content	12	12	12	12
Inert matter	2	2	2	2
Maximum red rice	0	0	5 seeds/kg	5 seeds/kg
Noxious weed seed	10 seeds/kg	10 seeds/kg	0.5%	0.5%
Other species	10 seeds/kg	10 seeds/kg	0.5%	0.5%

2.3 MAIZE- Zea Mays SEED PRODUCTION (OPVs):

Open pollinated varieties seed production, as the name implies is the production of seed where the crop plants are fertilized through free cross pollination of plants on the field within and without. On the contrary hybrid seed production depends on controlled pollination of the female plant by the male.

Current varieties released and grown in Sierra Leone:

Western Yellow, TZSR, DMR and recently introduced QPM (OBatampa) variety from Ghana and Zambia.

Mode of reproduction of maize plant-Generally by open/cross pollinated varieties

- Plant reproductive system consists of male and female flowers
- Male flowers called tassel
- Female flowers called silk.
- Male flowers produce pollen
- Female flowers produce ovules.
- Different plants cross pollinate to produce seed/grain

Mode of fertilization:

- Wind
- Insects
- Animals
- After fertilization pollen germinates, grows through the silk and fertilises the ovule.
- Fertilized ovule grows to form the seed/grain

Seed production:

- Obtain foundation/basic seed of desirable traits/characteristics/ recommended variety for ecology
- Common traits are yield, disease and insect resistance/tolerance
- Production must be consistent with quality.
- Obtain foundation seed from national program or import from international centre.

Choice of land:

- Land is accessible and free from disputes.
- Fertile and well drained soil
- Accessible for field operations and conduct of field inspections.
- Free from noxious weeds.
- Consult with neighbors when and where they will plant their maize
- Other local conditions such as rainfall, farming activities and market possibility.

Isolation:

- By space: maintain a distance of at least 200-300m between seed crop and other fields of maize different variety.
- By time, sow seed crop a month earlier or later than neighbouring maize fields.
- Certified seed barriers. Genetically pure seed of same variety may be planted close.

Crop field management:

- Good land preparation at least 2weeks prior to planting.
- Plant seed at recommended rate (20kg/ha).
- Spacing between rows for 105-110 day variety: 80cm
- Spacing within rows for 105- 110 day variety : 30cm
- Timely application of fertilizers: basic fertilizer, NPK ½ at recommended rate at the time of planting, and 1/2 4-6 weeks after planting.
- Top-dress at vegetative stage with Urea or Sulphate of Ammonia at recommended rate.
- Use of cover crop or animal manure can help reduce amount of fertilizer
- Apply fertilizers at recommended rates, consult research or extension services if in doubt.
- Timely weeding: 2-4 weeks first weeding and 6-7 weeks second weeding for manual weed control.
- Timely harvesting to avoid insects and moulds.

Elimination of undesirable plants/rouging:

- Conduct frequent visits to the field.
- Off- types and the process of removal is called rogueing.
- During harvest and drying avoid admixture with other maize grain varieties

Harvest and drying:

- Avoid admixture with other maize varieties or grain.
- Select best and healthiest ears and kernels for seed.
- Discard off types, rotten, insect infested germinating and damaged ears.
- Spread selected ears on clean, dry surface, preferably a patio or tarpaulin and allow to dry to safe moisture level (12-13%)

Shelling, cleaning, treatment of seed:

- Shell or store ears at safe moisture level.
- Clean seed manually or with seed cleaner
- Involves removal of dirt, insect damaged, shrivelled seed, diseased, starting to germinate from the good seed.
- Treat seed with insecticide/fungicide as required.
- Store in a cool dry environment.

Quality control procedures followed during production:

- Field Inspections to ensure:
- Source of seed
- Pedigree
- Genetic purity
- Appropriateness of the seed for the ecology
- Cleanliness of machinery etc.

Quality control tests:

Common Tests are:
Moisture Content.%
Germination%
Physical purity%
Vigour

Conducting moisture tests:

- Moisture tests are conducted using moisture meters.
- Different types of moisture meters are available.
- Some are only suitable for the seed testing laboratory and others are portable and can be carried to the field.

- A difference of +- (1-2%) between meters is acceptable.

Conducting germination tests:

- In the laboratory tests using both soils in a tray and paper towel in a germinator can be conducted.
- For a seed producer the soil test may be easier by the following method:
- Construct a simple wooden box with suitable dimensions.
- Fill the box with insect free loose soil
- Water the soil thoroughly and plant 100 seeds.
- Count germination percentage after a number of days usually, 4-8 days.
- Calculate germination percentage by expressing number germinated over 100.

Rules and regulations guiding the production of maize seed

Classes of Seed:-

- The four classes of seed recognized for the purpose of seed certification are Breeder/Prebasic Foundation/Basic, Registered/Certified 1 and Certified 2 seeds. Only sound ears free from transmissible non-controllable diseases shall be selected for the production of these classes of maize seed.

Field Inspection:-

- At least two field inspections shall be made by the certifying authority or his representative at a time when varietal purity can best be determined. This shall be before silking and soon after the milk stage when the leaves are still green

Rules for certifying OPV maize seed

Field Standards

- (i) Isolation – Field must be completely isolated from other maize fields. In forest areas, the distance shall not be less than 150 meters and in grassland areas, not less than 300 meters.
- (ii) Sanitation-The field must be clean and free from volunteer plants.
- (iii) Purity of Crop – There should be not more than 5 per cent of ears of admixture according to the class of seed.
- (iv) Plant Characteristics – Plants must be vigorous and free of excessive lodging and diseases.
- Height of plant and height of ears on plant must be reasonably uniform according to the variety.
- Ears should have a good tight long husk covering.

- (v) Growth Period – Fields must be reasonably clean of weeds during the growing period.

Seed standards:

- (i) A representative sample of not more than 2 kilogrammes of the seed as produced for sale shall be obtained by the certifying authority. If the grower has more than one batch of seed, a referee sample shall be obtained for each batch.
- (ii) Varietal purity - The seed must be at least 95 percent pure as to variety
- (iii) Pure seed - The seed must be at least 95 percent mechanically pure.
- (iv) Germination- The germination shall not be less than 85 percent.
- (v) General appearance- The seed shall be bright in appearance. When shelled the seed shall be reasonably uniform in size and colour.
- (vi) Moisture content: Shall not be more than 13% for all classes..

2.4 SORGHUM SEED PRODUCTION (Sorghum vulgare)

Acquisition of basic seed

Obtain quality seed from relevant institution.

Site selection:

- Choose site with well drained fertile soil relatively free from:
- Birds, diseases, pests, high humidity during ripening period;
- Strong winds.
- Also consider temperatures and day lengths and related wild species of sorghum

Land preparation:

- Seeds are relatively small, therefore moist weed free soil with fine tilth preferable.
- Consult neighbours when in doubt about their cropping plans.
- Previous cropping history, at least two years after a sorghum crop.
- Drill or plant in rows when rows are established.

Fertilizer application, weeding and thinning:

- Apply fertilizer at recommended rate, in doubt consult Field Services of MAFS.

- Timely manual weeding, usually 2-3 times during crop growth.
- Alternatively apply herbicide or a combination of both, based on choice, cost, and or availability.
- Herbicide can be applied at pre or post planting
- herbicide are also classified as selective or total.
- Selective when the herbicide kills only the weeds and leaves the crop.
- Total herbicide does not discriminate between crop and weeds; it kills all.
- Thin crop to required plant population.

Plant protection:

- Sorghum is generally tolerant to most prevailing diseases.
- However avoid growing in disease endemic areas.
- To avoid birds use resistant variety or scare.
- Rogue plants thoroughly to remove off-types.

Harvesting, threshing and post harvest handling:

- Hand harvest or use a combine harvester after final inspection.
- Harvest early to avoid lodging.
- Avoid mechanical admixtures when combines are used.
- Sundry to avoid moulds.
- Thresh manually or use thresher
- Winnow to remove trash.
- Dry clean seed to safe moisture level (11-12%).

Treatment, packaging and storage:

- Treat seed with recommended chemical.
- Package in suitable container, usually moisture proof, and seal to avoid moisture.
- Conduct purity, moisture and germination tests to ensure seed meets minimum quality standards.
- Store in a cool, dry environment.
- Conduct periodic tests to revalidate quality.

Rules for certifying sorghum seed

Classes of Seed:-

- The four classes of seed recognized for the purpose of seed certification are Breeder Foundation, Registered and Certified seeds.

Land Requirements: -

- No other cultivated variety of annual sorghum shall have been grown the previous two years except a crop of the same variety grown from an equal or higher certificated seed class.

Field Inspection:--

- (i) Fields producing Breeder, Foundation and Registered seeds shall be given two field inspections: one before flowering and one at full seed color development stage.
- (ii) Fields producing certified seed shall be inspected twice before harvest but after the seed begins to assume colour.
- The first field inspection shall be made at bloom.
- The second field inspection shall be made before harvest but after the seed begins to assume mature colour.
- (iii)Restriction on Number of Varieties:-
- If more than one variety is grown, mechanical mixing and crossing must be avoided.

FIELD STANDARDS

Isolation:

- Fields acceptable for the production of Breeder, Foundation, Registered or
- Certified seeds must have the minimum isolation distance from fields of any other variety of the same crop that does not meet the varietal purity requirements for certification as given below:
- Breeder seed--------- 500 m
- Foundation seed --- 350 m
- Registered seed----- 350 m
- Certified seed ------- 200 m

Table 5: Specific requirements

Factor	Breeder	Foundation	Registered	Certified
Off-types (definite)	Nil	Nil	1/50000	1/20000
Off-types (doubtful)	Nil	Nil	1/10000	1/100000
Noxious weeds	Nil	Nil	Nil	Nil
Head smut	Nil	Nil	Nil	0.01%
Kernel smut	Nil	Nil	Nil	0.04%

SEED TESTING STANDARDS

Seed Standards

A representative one kilogramme sample of the seed produced for sale shall be obtained by the certifying authority. If a grower has more than one batch of seed, a referee sample shall be obtained for each batch.

Table 6: Seed Standards

Factor	Breeder	Foundation	Registered	Certified
Varietal purity.	100	99.9	99.7	99
Specific purity	99.9	98	98	98
Inert matter	0.01	2	2	2
Other sp/kg	Nil	10 seeds	10 seeds	10 seeds
Noxious weed seed/kg	Nil	10 seeds	10 seeds	10 seeds
Germ%	90	85	80	80
Moisture content	12	12	12	12

2.5 BEAN SEED PRODUCTION (Phaseolus vulgaris)

Bean is a self pollinating crop

- Only about 5% is cross pollinated mainly by insects
- Both reproductive parts are on same flower but different locations.
- Unlike the maize plant, bean plant self fertilises itself.
- Isolation distances are not as critical as maize.
- Performs under various ecologies.

Seed production:

- Choose variety to suit ecology, rainfall and soil conditions.
- Obtain foundation/ Basic seed from relevant institution.
- Isolation not as critical (3m)
- However avoid mechanical admixture

Land preparation and agronomic practices:

- Good land preparation
- Plant seed at recommended rate (under rain-fed 60-120kg/ha of large seeded variety and 35-70kg/ha for small seeded varieties.
- Plant one seed/ hole, 7-15cm apart.

Fertilizer application

- Cowpea can synthesise atmospheric nitrogen for its own use
- It also benefits from organic and chemical fertilizers on depleted and marginal soils.
- Apply phosphorous fertilizer at recommended rate/ 50-60kg/ha.

Weed control

- Good seed bed preparation or use No-till.
- Timely and good weeding/manual/herbicide.
- For manual weeding, weed 2-3 weeks after planting

- When canopy closes, weeds may not be a problem, 6-8wks after planting.

Insect and pest control:

- Most new varieties are resistant to major bean diseases.
- Where necessary use treated seed, cultural or recommended chemical.
- Use recommended chemical for insect control
- Pull out and burn disease plant to prevent spread.
- In doubt contact Agric extension services of MAFS.

Roguing

- Inspect field and remove plants that show disease and pest symptoms
- Remove plants that show a deviation from varietal characteristics.
- These include, days to flowering, flower colour and height.
- Remove problem weeds such as Striga and Rotboellia exaltata.

Harvesting, Drying and shelling:

- Harvest on time to avoid losses due to shattering, mould and rot
- Dry on clean patio or tarpaulin
- Thresh when dry to safe moisture level.
- At partial drying of 14-15% seeds can be threshed.
- Threshing can be manual or with mechanical thresher.
- In all cases exercise care not to damage seed.
- Further dry seeds to about 10-12% for storage.

Treatment and storage:

- Treat seed with recommended chemical.
- Check with a reputed chemical dealer or Extension/Plant Protection Services Directorates of MAFFS.
- Package and store in a cool, dry, clean environment.
- Use durable moisture proof packaging material to avoid re-absorption of moisture to cause pre-germination.
- Conduct periodic tests to revalidate quality.

Quality control and seed testing:

- Periodic field inspections are conducted at crop growth to ensure removal of off-types, good field sanitation, and plant population and yield determination.
- Usual seed testing determinants are moisture, purity and germination.
- Certification can be granted when field and laboratory standards are met.

Conducting moisture testing:

- Moisture tests are conducted using moisture meters or using the oven method.
- Different types of moisture meters are available.
- Some are only suitable for the seed testing laboratory and others are portable and can be carried to the field.
- A difference of +- (1-2%) between meters is acceptable.

Conducting germination testing:

- In the laboratory tests using both soils in a tray and paper towel in a germinator can be conducted.
- For a seed producer the soil test may be easier by the following method:
- Construct a simple wooden box with suitable dimensions.
- Fill the box with insect free loose soil
- Water the soil thoroughly and plant 100 seeds.
- Count germination percentage after a number of days usually, 4-8 days.
- Calculate germination percentage by expressing germinated over 100.

Rules for certifying cowpea seed (self pollinated):

- Classes of Cowpea Seeds: There shall be four classes of seeds, namely Breeder, Foundation, Registered and Certified seeds recognized for the purpose of certification. Land Requirement: A crop of cowpea shall be eligible for certification if planted on land on which cowpeas were not grown the previous two years, volunteer or otherwise, unless the preceding cowpea crop was grown from certified seed of the same variety. A field which includes an area where cowpeas were threshed or where thresher refuse was spread during the preceding year shall not be eligible for certification.
- Field Inspection
- Field inspections shall be made as often as the certifying authority may determine.

- On field inspection, the inspector shall investigate the facilities for harvesting and storing the seed to prevent mechanical admixture.
- Restriction on Number of Varieties: Only one variety shall be grown per field.

Field standards:

Isolation:

- Breeder seeds: A distance of at least 25meters from other varieties.
- Foundation at least 10 meters from other varieties of same crops
- Registered and Certified see: 5-10 meters from other varieties of same crop.

Seed standards:

Moisture content – the moisture content of each class of cowpea seed shall not be more than 9%.

Certified cowpea seed shall not be stored in the same building with other cowpea varieties, unless previously bagged, tagged and sealed or unless they are otherwise identified

A representative 1 kilogram sample of the seed as produced for sale shall

be obtained by the certifying authority. If the grower has more than one batch of seed, a referee sample shall be obtained for each batch.

Table 7: Seed Standards

Factor	Breeder Registered	Foundation	Registered	Certified
% Varietal purity	99.5	98	98	98
% specific purity	99.5	98	98	98
Inert matter.	2	2	2	2
Noxious weed	0	0	0	0.1
Germination %	80	80	80	75
Other crop seed	Nil	Nil	Nil	Nil
Weed seed/kg	0	0	0	0.1

2.6 GROUNDNUT SEED PRODUCTION (Arachis hypogea)

Groundnut is a very important crop in the diet of the Sierra Leonean. It is widely grown for consumption as a confectionary, fried, boiled or eaten raw; not generally for oil extraction. Development of improved varieties and technologies is the mandate of SLARI. Current improved varieties under production include Marais, Slinut and JL 24. These were varieties released in the 1970s and very little technical information is available.

Soil conditions

Groundnuts thrive very well on a well drained sandy loam or sandy-clay-loam soil, with good amount calcium and moderate organic matter.

Recommended cultural practices

Source of seed

Plant recommended varieties. The seed should be kept in shell until shortly before planting.

Land selection/ preparation

Select deep, well drained sandy loam soils with fair amount of organic matter. Fairly flat fields are ideal for groundnut seed production. Conventional tillage may be practised by ploughing and harrowing, or a no-till method may be used. This can be accomplished by slashing the weeds, allowing them to regenerate and then spraying them with a total herbicide such as glyphosate (Roundup).

Isolation

Groundnut is self pollinated, and the chance of out-crossing is minimal. However for purposes of accidental admixtures a distance of about 5 meters from a neighbouring groundnut field is adequate for isolation.

Sowing/spacing

Plant one groundnut seed per stand/hill. To achieve optimum plant population, inter row spacing should be 60cm, intra plant 15-20 cm and planting depth of about 5-10cm. For the spreading varieties the spacing should be about 70cm inter row and 20-25cm intra plant.

Weed control

Poor weed control greatly reduces the yield of groundnuts. Weed control can be manual or use of herbicides. Weed control is particularly critical after the first forty five days after sowing. For manual weed control, control of weeds is effective when a minimum of two weeding are done. The first weeding should be done after twenty days and the second after fifty days after sowing. Time of weeding also depends on the land preparation. Weed control should do in such a way as to avoid damaging the developing pods.

Fertilizer application

Groundnut is a leguminous crop and therefore produces nodules which synthesise atmospheric nitrogen into nitrates for its own use. It can also benefit from the applications of organic or chemical fertilizers on depleted, marginal or poor soils. The crop performs poorly when the soil is deficient in phosphorous, calcium and other micro nutrients such as sulphur. Therefore the application of sulphur containing fertilizers, such as Calcium Ammonium Nitrate (CAN) containing sulphur enhances yields increases. An application of 100kg/ha of single superphosphate is highly recommended. The fertilizer should be applied in a band on ridges or broadcast and ploughed in before sowing. The crop benefits from the practice of crop rotation especially when groundnut is grown after a maize crop.

Roguing

This activity entails the removal of plants that show disease and pest symptoms and plants which deviate from the normal characteristics of the variety particularly, days to flowering, flower colour, plant height etc. Problem weeds such as Striga and Rottboelia exaltata must be removed.

Harvesting

Harvesting should be done at the right time, as some varieties have very short dormancy period and will start germinating on the field when the crop is fully mature. This may reduce the quality of the seed. Groundnut seed is mature when the inside of the seed is spotted pale brown. If 75% of sampled plants show dark colour inside the shell, then the groundnuts are mature and ready for harvesting. The fall of leaves although important, is not necessarily an indicator for seed maturity. Timely harvesting of groundnuts of groundnuts is essential to avoid discoloration of nuts, germination, and pods remaining in the soil contaminated with aflotoxin.

Drying and Storage

Harvested pods should be quickly and thoroughly dried before storage. Groundnuts should be dried in dry containers. Storage under wet conditions will promote the development of the fungus Aspergillus flavus which leads to aflotoxin contamination. Groundnut seed

should be bagged and stored in pods. The bags should be stacked on wooden planks to avoid damage from rodents, dampness from the floor and wall.

Packaging

Groundnuts seed should be packaged in new bags to avoid contamination. All packaging materials should be well labelled.

Seed testing

Before and after storage, a laboratory or field test must be conducted to determine the value of the seed for planting. In the laboratory, seeds are purity-tested to determine the percentage by weight of other varieties, other crops, followed by a germination test to determine the percentage of seeds that can grow.

Table 8: Groundnuts seed and certification standards

	Parent Seed	
	Breeders/Basic	Certified
Minimum standards	4 field 2 post harvest	2 field 2 post harvest
Isolation	10 metres	5 metres
Previous cropping	No groundnut for 2 years	No groundnut for 2 years
Standards: 1 Field 2 Seed inspection	No more than 0.1% offtypes at any inspection No more than 5% Rosette infection at any inspection No more than 1% small, shrivelled/ damaged seed Purity: 98% Germination: 80% Shelling: 70%	No more than 0.3% offtype at any inspection No more than 10% Rosette infection at any inspection. No more than 0.1% undesirable shell/seed No more than 5% small/shrivelled/damaged seed Purity:97% Germination:75% Shelling: 70%

CHAPTER THREE: FIELD INSPECTION: TECHNIQUES, PROCEDURES AND PRACTICES.

3.1 THE SEQUENCE:

Application for inspection:

- This is administrative
- Early application to certifying agency, preferably before start of growing season
- Details should include, name of seed grower, location of field, crop species and variety, origin of planting seed, certification class, and amount of seed and area to be planted.

Role of certifying agency:

- Check details of the application to:
- Monitor multiplication by verifying source and suitability of seed to be planted.
- Examine cropping history of fields used for seed multiplication.
- Register seed growers and accept those whose past performance has been good.
- Control transport of seed to conditioning plant.

Field inspection procedure:

- Inspect and evaluate all fields equally and uniformly.
- Accurately measure the occurrence of each contaminant.
- Spend the least possible time on each field.
- Fields are inspected based on samples, and by the general overview.

Field overview:

- Inspect and evaluate all fields equally and uniformly.
- Accurately measure the occurrence of each contaminant.
- Spend the least possible time on each field.
- Fields are inspected based on samples, and by the general overview.

What to look for:

- Walk through all parts of the field
- Follow a specific pattern of walking to see the entire field.
- Inspect all fields uniformly.
- Minimize walking distances and time spent on one field.
- This allows accurate assessment of the field.
- Different patterns are attached to presentation.

Field inspection sample

- Unlike the field overview, which provides a general assessment of field, this examines in detail the plants in detail using a sample/portion of the field.
- Detailed counts of contaminants are made and the numbers recorded compared against standards.
- Size of sample depends on tolerance limit allowed by field standards but statistically large enough to include 2-4contaminants yet acceptable by the standards.
- That is a field inspection sample which includes three times the number of seed crop plants in which one contaminant is permitted ie if 3 or fewer contaminants are counted the field is accepted.

Field counts:

- For accurate representation of the quality of the field the sample area is sub-divided into 5-6 units randomly located in different parts of the field.
- Each field count includes 1/5or 1/6 of the sample area.
- Divide number of plants/area in the total field inspection sample by number of field counts gives the number of plants in each field count.

General procedures:

- Grower contact/before inspection
- Inform seed grower in advance of when field is to be inspected.
- Examine growers records to verify: cropping history, variety, category and origin of seed planted etc.
- Grower should normally accompany inspector to the field for inspector to explain standards, principles and procedures of field inspection.

Field shape/ Plant density:

- If field is rectangular in shape use regular pattern of walking through the field for the field over-view.
- Modify pattern if field is irregular but indicate as remarks in the inspection form.
- Always determine the plant density as part of the inspection criteria.

Making the field overview:

- Before entering the field check field Inspection Report Form for details of :
- Field location
- Field number
- Field area planted.
- Cropping history
- Variety
- Certification class.

Previous cropping history:

- During the inspection, advise grower to correct observed problems that can easily be corrected.
- Schedule another visit if more time is needed to revisit the field after problem is corrected.
- If field has un-acceptable cropping history, purity is not acceptable, field is rejected.

Lodging:

- If more than 1/3 of field is lodged, reject field.
- If however field may recover later, schedule a second inspection.
- Use position of sun as an aid to identify easily contaminants.
- For low-growing crops stoop down from time to time to observe crops critically.
- Remove all rogued-out contaminants from the field.

General observations during the field overview:

- Identify and confirm variety grown using morphological etc characteristics to reject if variety grown is wrong.
- With excessive contaminants in some parts of the field reject.
- Note and record the number of weeds specified in the standards and also plants infected with diseases not specified in the standards.

Isolation

- Examine the area within the isolation distance on all field sides for, other fields or volunteer crops

Ensure field edges, drainages, roadways, irrigation structures etc are free of plants which may contaminate the seed.

3.2 PROCEDURES FOR INSPECTIONS AT SPECIFIC GROWTH STAGES:

- Note: Some contaminants do not change as the seed crop matures, so only one inspection may be required, usually at a time when varietal characteristics are easy to see.
- Different inspections are made at specific stages of the crop where contaminants are best identified.

Inspections before/during planting:

- Verify field cropping history.
- Verify the source, variety, class and acceptability of planting material.
- Verify proper use of agronomic practices such as land preparation, planting method, acreage etc.
- Verify proper cleaning of equipment used in planting operations.
- Verify details on application form.

Inspections during pre-flowering:

- Verify that seed planted is of origin, source and class acceptable for growing a seed crop.
- Verify that the field meets land cropping history requirements.
- Verify that only one crop and variety is grown on the field
- Confirm that the area actually planted is the same size as the area applied for.
- Verify the occurrence in the field or within the isolation distance of off-types and other varieties, other crop species, undesirable weeds and diseased plants.
- Where contaminants are present, compare their growth stage with that of the seed crop to determine if the seed crop may be contaminated, especially if the contaminant can produce seed likely to contaminate the crop
- Verify that all volunteer and contaminant plants within the isolation distance are removed before they cause contamination
- In self pollinating crops, inadequate isolation may be corrected at any time before harvest, but subsequent inspections should verify that isolation was corrected.
- For some crops verify that no fields of other varieties are grown on the farm.

- Advise farmer on how to identify and rogue contaminants.
- For some crops verify that no fields of other varieties are grown on the farm.
- Advise farmer on how to identify and rogue contaminants.

Inspections during flowering:

- At first inspection verify all factors listed for inspections in earlier growth stages.
- If a second inspection, confirm observations made in previous inspections.
- Verify isolation as flowering is a critical stage of contamination.
- Flowering is best time to identify contaminants.

Field counts:

- Take field counts to determine: Off-types and other varieties, other crops whose seed is inseparable, undesirable or noxious weeds and plants with symptoms of specified diseases.
- Explain to grower how to remove certain contaminants/correct certain factors which must be verified by re-inspection.
- Set a date for re-inspection.

Inspections during post flowering:

- Confirm observations in previous inspections; if that is the first inspection, check factors listed under previous inspections.
- Determine the occurrence of contaminants which may not have been visible in earlier inspections.
- Check the efficacy of roguing and verify the removal of contaminants.

Inspections during pre-harvest:

- Inspections must be made immediately after crop matures to avoid delay in harvesting.
- Verify all observations made during previous inspections.
- Check varietal purity by observing characteristics which could not be seen at earlier stages.
- Check adequacy and cleanliness of growers harvest /handling equipment and facilities.

Inspections during harvest:

- Verify all factors not verified in previous inspections.
- Verify that rejected areas were separately harvested and removed.

- Verify cleanliness of harvest and handling equipment and facilities.
- Ensure that seed delivered to the conditioning plant will only be from the field, or field part which met the all standards.
- Assist grower to cart seed to conditioning plant.

Qualities of the inspector:

- Must be honest.
- Dedicated
- Willing to work.
- Ability to see undesirable plants.
- Familiar with seed technology from variety development to final seed use.

Must not only be an inspector or law enforcement officer but also:

- Extension leader to train and guide growers and seed staff in production, harvesting, conditioning, storage and promotion.
- Inspectors are carefully trained in identifying varietal characteristics and contaminants.

Equipment for inspectors:

- Transport and operating funds.
- Measuring tape for measuring isolation distance, row spacing, etc in fields.
- Inspection report forms
- Cords and small stakes for marking off- test areas always prepared in advance.
- Paper bags and small labels with attached twine to label plant specimens taken for identification
- A pocket magnifying lens to observe plant micro-characters in case of difficulty in identifying contaminants.
- A hand held counter or simple written tally for counting contaminants in a field count.
- Identification manuals for crop varieties, undesirable weeds, seed-borne diseases etc for reference purposes.
- Sample field inspection form is attached.

CHAPTER FOUR: ROOTS AND TUBER PLANTING MATERIAL PRODUCTION.

Procedures for cassava and sweet potato production:

4.1 CASSAVA PRODUCTION

Introduction

Cassava is the second most important staple crop in Sierra Leone. It is eaten as a root crop and the leaves as a vegetable sauce. Acreage under cultivation varies from district to district but highest acreage is from the southern sector of the country.

In recent past, several varieties have been released by SLARI and are in cultivation for a considerable number of years. Cassava planting material production had been ongoing until the onset of the civil war in Sierra Leone in the 1990s. Production resumed briefly after the war under the management of a new Seed Project, titled ``Development of a Sustainable Seed Program in Sierra Leone'' but ceased after almost half a decade now. It is the intention of the new project under current management to resume cassava planting material production. Production would however largely depend on the release of new varieties, maintenance of old varieties and demand from farmers. Farmers engaged in cassava planting material production would be taught and guided periodically on the technology of production.

PLANTING MATERIAL PRODUCTION

Although cassava and sweet potato planting materials can be produced from true seeds, or rapid multiplication method, they are generally propagated through the vegetative parts. The criteria used in determining quality of planting materials of cassava and sweet potato are generally based on the threshold levels of infestation of diseases and pests. For common diseases, such as the African cassava mosaic virus, cassava brown streak, anthracnose disease and cassava leaf blight, threshold levels are determined during field inspections, to ensure good planting material production.

The incidence, levels of damage and reduction in quality to the plants caused by arthropod pests such as Green mites, Cassava Mealy bugs, spiraling White flies pests are also determined. Crop fields which fall within the acceptable score range of quality standards, qualify as good planting materials, while those outside the range are rejected.

Apart from diseases and pests incidence, the production of cassava and sweet potato planting materials also entail certain difficulties. Some of these are bulkiness, low multiplication ratio which requires transporting high volumes of planting materials which may result in damage to cuttings, to production fields. Therefore special care needs to be taken during the multiplication process. In the case of sweet potato, virus diseases which are systemic and difficult to control can be easily transmitted. Also in times of drought especially in

the dry season, sweet potatoes vines easily desiccate, become short lived and therefore have very low recovery rates. Hence the lack of interest by most seed companies in producing vegetative planting materials as a commercial venture. The seed supply system relies mainly on Governmental institutions, NGOs, religious groups and smallholder farmers. Special care needs to be taken during the multiplication process.

For both cassava and sweet potato the use of disease free, mature, true to type planting materials are recommended to start the process of multiplication.

Classes of seed/planting materials

Just like cereals and legumes the classes of planting materials are:

1 Breeder seed: Breeder seed is the variety released and maintained by the breeder.

2 Basic/foundation seed: This is the progeny of breeder seed. Its production is normally under the control of mandated institutions under the direct supervision of a national certification agency.

Certified seed: This is produced through the multiplication of basic/foundation seed.

Stages of seed multiplication:

There are three levels of multiplication outlined as follows:

Production at Primary sites:

At the primary stage, production sites are either at or close to the research station for easy supervision by research scientists.

Production at Secondary sites:

At the secondary multiplication stage, production sites are managed by mandated institutions such as foundation seed producing institutions, extension services directorates/departments of the Ministries of Agriculture, religious groups or NGOs. These institutions/agencies are normally backstopped by the breeders/researchers through training about the varietal characteristics and multiplication system of the varieties.

Production at the tertiary site

Under tertiary production, fields are managed by small-scale farmers, NGOs, but under the supervision of a certification scheme.

THE MULTIPLICATION PROCESS

The conventional method:

The conventional cassava multiplication method is the easiest and most widely used. However it has the disadvantage of having a low multiplication ratio (1:10), unlike the rapid multiplication technique which has a higher multiplication ratio of (1:60-100). Also materials are bulky and transportation might pose a problem if in large quantities. In deciding to produce cassava planting materials as a commercial venture, the following considerations may aid quick decision making:

a) Access to market b) previous cropping, land should not have been used to crop cassava in previous season to avoid volunteer crops. c) Land should be accessible and free from animal damage d) Fertile and well drained soils e) Free from disease and pest pressure e) Isolation distance should be at least 100m from other cassava fields for certified basic and certified seed production and in the case of breeder seed at least 200m.

Variety

A variety should be recommended by research, a seed production agency or a variety of high demand by the local community. Two types of crop varieties are generally bred and released by researchers: a) industrial crop varieties b) varieties for consumption. In the case of industrial crop varieties the objective is to breed for yield, starch content and quality. For food consumption the consideration is generally for yield, cooking ability, good in-ground storability and tolerance to pests and diseases. Which ever be the case the demand must be there.

Land Requirement:

Land for cassava seed production should meet the following requirements:

- Free from volunteer plants/ previous cropping should be at least 2 years under cassava.
- Free from swampy and shaded conditions
- Free from cassava residue and drainage from other cassava fields
- Accessible to beneficiaries
- Away from high pressure areas for cassava pests and diseases
- Fertile and well drained
- Away from other cassava fields; at least 200 meters for breeder seed and 100 meters for basic and certified seed

Choice of planting material

Recommended varieties are preferable. However, newly released varieties with high demand for food consumption and industrial use are mostly recommended.

Land preparation and planting

Land for cassava seed multiplication should be prepared early, either by use of no till, ploughing with a tractor hoe or mounding. Land should be prepared early to enable planting with the early rains. Early planting enables the crop to establish while thereis still adequate moisture.

Planting material

Only good quality planting materials should be used. The guidelines for selecting good quality planting materials are:

- Plants that are mature, about 7-12 months old and there should be latex from cut ends.
- Healthy plants with robust stems and branches, lush foliage and minimum damage from pests and diseases.
- Avoid plants with pests and diseases. Many cassava pests and diseases are stem-borne and are spread through distribution and planting of infested or diseased cuttings. Major cassava pests are cassava mealy bug, cassava green mite. The major diseases are the African Cassava mosaic virus, cassava bacterial blight, cassava brown streak disease and cassava anthracnose.
- Avoid wounding/ bruising stems. Wounds are potential entry sites for pathogens.
- Treat cuttings infected with cassava mealy bugs and cassava green mites with recommended pesticide before distribution/planting.

Maintenance of fields

Planting material fields should be weeded and fertilized with the recommended fertilizer and rates applicable. Where soils are relatively poor, apply the fertilizer to boost stem growth. Routinely inspect field to ensure infected diseased plants are uprooted and destroyed.

Roguing

Good planting materials should be true to type with no admixtures. During field inspections off-types must be identified uprooted and destroyed by burying or burning.

Stem harvesting

In a well managed field, the stems are mature and ready for harvesting within 7-12 months. Since the objective is stem production, the plants are not uprooted, but cut 20-25 centimeters above the ground. Several shoots sprout from the stumps after rationing. These should be thinned to 2-3 per stump, which will mature into stems. These can be harvested at a later stage approximately 9-11 months.

Post harvest management

After rationing, fertilizers should be applied where possible to boost growth and the field should be kept weed free. Another set of stems can be harvested 9-11 months after ratooning. The process can be repeated as many times as possible as long as there is no build up of diseases and pests. The number of stems that can be harvested depends on the variety, soil fertility and management of weeds, pests and diseases. However, ratooning is not recommended, where disease pressure such as the African Cassava Mosaic is high. Special care needs to be taken during the multiplication

At and after harvesting care should be taken to avoid bruising the stems since bruised buds may not sprout.

Table 9: STANDARDS FOR INSPECTING AND CERTIFYING CASSAVA PLANTING MATERIAL

FACTOR	STANDARD	MAXIMUM PERMITED
General. Land requirement	Land for cassava multiplication should be free from volunteer plants. Cassava residue and drainage from other cassava fields should be avoided.	N/A
No of inspections	Four inspections: 1. up to one month old 2. up to 4 months old cassava 3. up to 7 or 8 months old cassava 4. prior to cutting of stakes	NA
Isolation	Distance from different or same variety be separated by	5 meters
Age of stem cutting at harvest	7-12 months old and there should be latex from cut ends.	NA
Field labeling	Field should be labeled as follows(Variety, date of planting, size of plot, name of grower)	**NA**

Agronomic: Genetic purity	According to breeders specification and morphological characterization.	0.1% primary site, 0.2% for 2nd& 3rd sites
Refilling	Last refill not more than 3 months after 1st planting	**NA**
Weeds	Fields must be reasonably clean from weeds especially parasitic weeds	0.1%
Plant Protection: Insect pests; cassava green mites, cassava mealy bug, spiraling white fly	During 1st , 2nd and 3rd inspections, populations of insects above threshold (50 adults or larvae/leaf, be recommended for intervention eg use of natural enemies or other recommended appropriate treatments	0% or treat by dipping in recommended dilute pesticide solution
White scales (Aonidomytylus albus)	At harvests reject fields with populations above thresholds or recommend appropriate treatment before distribution or further multiplication	0% or treat by dipping in recommended dilute pesticide
Scale Mealy bug(Stitococcus spp)	Reject field if one or more pests are found (This is a serious quarantine pest)	0% or treat by dipping in recommended dilute pesticide
Diseases: African Cassava Mosaic Virus (ACMV)	Severity score shall not exceed 3.0 for 40% of plants for the 3 inspections. Fields with severe infestation should be rogued. At final inspection, infested plants should not exceed 0.5%	0.5%
Cassava Bacterial	Threshold shall depend on the variety, its susceptibility and the environment.	0%

Blight (CBB)	Reject field at 4th inspection if disease is observed.. Severity score not to exceed 2.0 for 20% of plants. All infested plants must be rogued and burned during 1st inspection.	
Cassava Anthracnose disease (CAD) Cercospora and bud Necrosis, etc	Severity score should not exceed 3.0 for 40% of plants. At harvest of stem cuttings infested plants shall not exceed 5% Pass all fields and discard infested stems with bud necrosis	**5%** Less than 10%

4.2 SWEET POTATO PLANTING MATERIAL PRODUCTION

Introduction

Sweet potato is equally a very important staple crop in Sierra Leone. It is grown and consumed extensively as a root crop, the leaves as a vegetable sauce and also as an income generating crop. Both roots and leaves are sold in the market. Over the past 15 years varieties have been released and are in cultivation throughout the various ecologies in the country based on attributes required by farmers. Some releases are based on yield, nutritional value and increased biomass, with the leaves serving as a vegetable sauce.

Sweet potato has a multiplication ratio of about 1:120. Comparatively this is low compared to the maize crop which has a multiplication ratio of 1:300. To increase the ratio will require the rapid multiplication method of producing planting materials. However, the conventional method is popularly used in the production of potato planting materials. The production follows almost the same trend like cassava.

Classes:

There are three classes; breeder, basic and certified.

Classes of seed/planting materials

Just like cereals and legumes the classes of planting materials are:

1 Breeder seed: Breeder seed is the variety released and maintained by the breeder.

2 Basic/foundation seed:
This is the progeny of breeder seed. Its production is normally under the control of mandated institutions under the direct supervision of a national certification agency.

Certified seed:
This is produced through the multiplication of basic/foundation seed.

Stages of seed multiplication
There are three levels of multiplication outlined as follows:

Production at Primary sites:

At the primary stage, production sites are either at or close to the research station for easy supervision by research scientists.

Production at Secondary sites:
At the secondary multiplication stage, production sites are managed by mandated institutions such as foundation seed producing institutions, extension services directorates/departments of the Ministries of Agriculture, religious groups or NGOs. These institutions/agencies are normally backstopped by the breeders/researchers through training about the varietal characteristics and multiplication system of the varieties.

Production at the tertiary site
Under tertiary production, fields are managed by small-scale farmers, NGOs, but under the supervision of a certification scheme.

THE MULTIPLICATION PROCESS:

The conventional method:
The conventional multiplication method of using the vines is the easiest and most widely used in the production of potato planting materials.

Site selection:
Production of planting materials is often done in nurseries and quite close to a water source. The land should be free from volunteer plants and therefore avoid sites where the previous crop was planted to sweet potato. The soil should be well drained, close to a perennial source of water, and away from high pressure areas for sweet potato virus.
Isolation distances should be at least 200m for breeder seed and 100m for certified seed.

Land preparation:
Beds for sweet potato production should be reasonably spaced to allow for easy working but generally about 1-1.5 meters wide and of a reasonable lengh is recommended.

Variety:
Plant a recommended variety or a variety with high demand by farmers, but should be tolerant to pests and diseases.

Vines: Good quality vines should be planted.
Guidelines for selection of good vines are:

- Select vines that are healthy, vigorous and lush growth. Tender and medium (semi-mature) parts for planting.
- Cuttings from bases of vines carry the sweet potato worm (SPW) and the sweet potato stem borer.
- Avoid plants with pests and diseases especially the SPW and the SPVD. Many sweet potato pests and diseases are stem=borne and spread through distribution and planting of infested or diseased cuttings.
- Vines for planting should come from actively growing and disease-free plants.
- The vines should be shoot tip cuttings since the meristematic cells are still actively dividing.
- 2-3 node cuttings are recommended.

Water the beds before planting and plant the cuttings vertically, at 10by 10cm with leaves outside the soil. Water the plants after transplanting.

Nursery management:
Water seed bed regularly and never should the seed beds allowed to be dry. Other management practices include weeding, fertilizer application and rogueing. It is important to keep potato nurseries weed-free especially in the first 4-5 weeks of crop growth. Care should be taken not to damage roots when weeding. It may be necessary to apply nitrogen fertilizer to boost crop growth but care must be taken to avoid rankness (tenderness of vines) which results in weak vines. All plants infected with viral diseases must be uprooted and destroyed by burying or burning away from the field. Similarly, all admixtures (off-types) must be uprooted and destroyed to maintain seed purity.

Harvesting
Harvesting should start when the vines are long enough, usually after 2 to 3 months after planting. Harvesting should be done for either further multiplication or commercial production. Harvesting is done by ratooning at 10 to 15 centimeters above the ground. Cutting of tips will promote side growth as the apical dominance will be removed. This will rise to more vines. With good management, two to three vine harvests can be done within a rainy season, as long as the plants are healthy and free from viral diseases and SPW.

Vine storage:
Planting of potato vines should be done preferably soon after cutting the vines. If however the fields are not ready for transplanting, it is recommended to remove most of the leaves to preserve the food reserves in the vine leaving only a few at the tip. It should also be worth noting that vines cannot be kept in good condition for more than two weeks. The vines should be tied in bundles with their bases covered with a wet cloth and kept in a cool area under a shade.

STANDARDS FOR INSPECTING AND CERTIFYING SWEET POTATO PLANTING MATERIALS

Table 10: CROP: SWEET POTATO

FACTOR	STANDARD	MAXIMUM PERMITTED
Land Preparation	Land for sweet potato vines and tuber production be free from volunteer plants. Residue and drainage from other sweet potato varietal fields	NA

	be avoided	
No of inspections	A minimum of 3 inspections and up to 4 inspections. 1st inspection-verify source of vines (from nursery), genetic purity assurance. 2nd inspection vines in nursery (multiplication site) 3rd inspection in multiplication site 4th inspection vines for wider distribution	
Isolation	Field of different or same variety be separated by	5 meters
Age of vines	At harvest vines for transplanting should not be woody and between 1-2 months old under good husbandry conditions	0.1%
Field labeling	Field should be labeled as follows: Field should be labeled as follows: (Variety, Date of planting,, size of plot, Name of grower	
Agronomic: Genetic purity	Strictly according to breeder's specifications/ characterization. Off-types should not exceed	0%
Plant Protection Insect pests: Potato beetle, Cylas spp and leaf deforliators	Vines should be reasonably free from Cylas spp damage. They should also have leaves which are free from A acerata caterpillars (leaf eaters)	0%
Slugs and wire worms	Cuts, bruises, cracked roots and vines should not exceed 1% by weight	1%
Diseases: Nematodes	For small roots meant for propagation at primary level strongly recommended to be avoided	0%
Scurf (Monilochaetes	Materials with disease symptoms to be rejected outright	0%

infuscas)		
Wilts (Fusarium oxyporum f. batatas	Materials with any disease symptom to be rejected outright	0%
Black rot (Ceratosmella fimbriata)	Final inspection should not have more than 5% of all mother plants(not individual vines)	5%
Viruses	All infested materials be rogued at early inspections	

CHAPTER FIVE: PRINCIPLES OF SEED CONDITIONING/PROCESSING: SHELLING, CLEANING AND GRADING.

Main Objective

The main objective of seed processing is to add value to the seed. Seed from the field contains various contaminants such as weeds, other crop seeds as well as inert matter such as stones, chaff, straws etc. Seed processing therefore includes all the operations which prepare harvested seed for planting. Processed seed ensures good physical quality, high germination percentage and vigour, freedom from seed-borne diseases, weed seed, and delivery in a form as required by seed users. It includes all the steps involved in the preparation of the harvested seed for marketing.

The steps include transportation from and to the warehouse, handling, shelling, pre-cleaning, drying, size grading, treating, storage and packaging. Processing is the final step, in any seed program, that converts raw seed into finished product, the seed. If well done, it assures that the previous efforts of the plant breeder and seed producer will result in high quality seed.

Reasons for processing seed:

- Removing other crops and weed seeds
- Removing immature and shriveled seed; some of these may be viable but of no agricultural value.
- Removing damaged seeds- broken, cracked, split or diseased and insect damaged seeds that are of low germination.
- Removing foreign materials- trash, chaff, stems, pods, insects, dust, dirt, stones, soil particles etc. These may not be harmful but tend to hold moisture and add to the weight of the seed lot.
- Size-grading; removing large and small seeds to secure uniformity.
- Improving seed lot appearance.
- Treating seed with protective chemicals
- Maintaining or improving seed germinability.

Basic steps:

- Sorting out good quality material.
- Shelling/ Threshing.
- Drying
- Cleaning.
- Treatment with insecticide/fungicide.

- Packaging.
- Storage.

Sorting:

- A practice where rotten, segregated or disease materials are selected out of the good seed.
- Pure good quality seed/cobs in the case of maize are dried and may be treated with an insecticide/fungicide before shelling and drying

Shelling and drying:

- Selected cobs or panicles are shelled/ threshed and dried down to the required moisture level.
- Shelling/ threshing can be done manually with a flail, or using machines such as maize threshers or combines. In some cases animal traction may be employed but this is not recommended for seed.
- In all cases what is important is to avoid high level of damage to the seed.
- For small-scale production use of simple hand tools are recommended.

Manual cleaning/Winnowing:

- In addition to the pure seed, harvested lots usually consists of all kinds of contaminants; shrivelled seed, stones, straw, other crop seed, insects, soil particles, damaged and deteriorated seed etc. which unduly add weight and reduce quality in addition.
- Seed cleaning is therefore a process in which all these contaminants are consciously removed to improve upon the quality and marketability of seed as well as meeting the standards stipulated by seed legislation.
- Traditional and small-scale seed production systems depend on natural wind flow.
- Larger/ commercial quantities depend on machines, simple or sophisticated depending on size of operation and quality standards set.

Mechanical: Use of machines to process/condition seed:
Steps in conditioning/processing:

These involve:

- Processes that the seed lot passes through from the time it is received into the ware house until it is offered for sale in the market.

- These processes are largely dependent on the moisture content and the level of undesirables in the lot.
- Some seeds may require re-drying and pre-cleaning while others may not.

Drying:

- Seed should be further dried down to a safe moisture level before any processing commences.
- Drying can be accomplished using natural sun or by artificial/ mechanical dryers.
- There are two types of mechanical dryers: Batch dryer, where seed is dried in batches and a continuous dryer where seed moves through a conveyor while heated air is being applied.
- All depend on the application of heated or natural air delivered by a fan.

Pre-cleaning:

- This is done when necessary.
- The process involves removal of large amounts of trash, by means of an aspirator.
- Machines for this purpose are called pre-cleaners or scalpers.
- Scalpers remove materials larger than the seed being handled.
- Scalpers may also perform the function of air screen cleaners.

Advantages of precleaning:

- Removal of large trash.
- Increase capacity of the air-screen cleaner
- Removal of large and small trash facilitates uniform seed flow which enhances efficiency of the air screen cleaner
- Removes high moisture green material, which would other-wise increase time and cost of artificial drying.

Principles of processing machines:

- Seed processing machines differ in sizes and complexities.
- But they all depend on the principles of differences in the physical properties of seed and that of the contaminants. Seeds and impurities which are not different in at least one of these characteristics, cannot be effectively separated; eg contamination with other varieties of the same species.
- The operator should be as familiar with seed quality properties and physical characteristics of seed and contaminants as he is with the processing equipment. Physical characteristics of seed are: size, weight, shape, surface texture, colour and electrical conductivity. The operator must be able to exploit these physical differences within the seed lot for better separation. The

operator should be familiar with the flow patterns generally used to process each seed crop. Furthermore, knowledge of the capabilities and limitations of each machine is important for successful seed processing.

- Seed processing requires several operations, for which many different machines are used. A single machine cannot separate seeds that differ in all the characteristics. Each single machine separates seed mixtures based on one or two characteristics only. If further separation is needed a different machine has to be used. During cleaning, machines make use of perforated metallic screens of corresponding sizes and shapes of the seed, fans, indented cylinders and colour separators.
- Satisfactory cleaning requires that the seed lots be processed in a specific sequence: pre-cleaning, basic cleaning, fine cleaning and grading. It may not be necessary for every seed lot to pass through all machines. The choice and sequence of the machines to be used depends on: 1) kind of seed being processed, 2)amount, nature and kind of contaminants present in raw seed and 3) quality standards that must be met.

Separation by size:

- Separation of seeds which vary in width, thickness and length can only be accomplished based on those differences with the accompanying contaminants.
- In the case of seed differences by width, but having the same length and thickness, separation of seed from contaminants, become effective using screens with round holes.
- In general, flat screens, as occurs in some air screen cleaners or indented cylindrical screens are to grade seed using width graders, on the basis of width differences.

Separation by thickness:

- Screens that have the same length and width but of different thickness are effectively cleaned with screens having oblong perforations. The width of the perforation is associated with the thickness of the seed. The screen may be flat as used in the air screen cleaners or a spiral grooved cylindrical screen as used in the thickness graders.

Length and weight separation:

- Length separation: Seed which have the same width and thickness but differ in length is also effectively separated/ graded using an indented cylinder.
- These are often referred to as length separators.
- Weight separation: Seed of different weights or specific gravity, are graded with machines in which the seed passes through an air stream and by a specific gravity table, which utilises a floatation process or a vibrating desk.

Shape and surface texture:

- Round seeds are separated from flat sided seeds using a vertical spiral separator, by allowing the seed to roll down the flights of the vertical spiral. The machine for this type of separation is known as a spiral separator.
- In the case of separation by surface texture, seed with a rough surface can be separated from seed of similar size but having a smooth surface, with a revolving fabric covered rolls as occurs in a roll mill cleaner.

Colour and electrical conductivity separation:

- Seed of the same size which differ in colour are normally separated by a colour sorter, using a photoelectric cell that has been calibrated to sort out off-coloured seed.
- Separation by electrical conductivity is of a limited application to a few crop varieties generally at the research level.
- This is possible by modifying the physical properties of some seed to ensure separation.
- The surfaces of some weed seeds become sticky when wetted with oil or water.
- Generally applies to seeds with cracked seed coats or rough or unbroken seed coats, and with addition of water, oil, saw dust or iron powder to the mixture and mixed properly, results in the formation of a pellet around the undesirables, large enough for separation to be effected on the basis weight or size.

THE AIR SCREEN CLEANER

Basic cleaning:

- The first stage of seed cleaning for almost all crops. The purpose of basic cleaning also known as fine cleaning is to remove impurities, which are larger and smaller in width and thickness and lighter in weight than the desirable crop seed. It is similar to pre-cleaning, but more refined and precise with slightly different machines.

- Basic cleaning is common to all kinds of seeds and it is usually performed by a machine called an air screen cleaner which operates by air suction and oscillation of two or more screens. A simple combination of air and screens permits the elimination of most impurities.

- The air screen cleaner is the basic machine in all the processing plants. Seeds should pass through an air screen cleaner before any further separation is attempted by other machines. It removes dust, oversize undersize and light weight contaminants, and from the seed. Many crop seed may be completely cleaned using just an air screen cleaner.
- Seed lots of almost all crops can be cleaned and made into an acceptable product with only this process.
- Other seed lots may require upgrading.

- Upgrading machines can function properly only when seed passes through basic cleaning.
- The air screen machine is therefore considered basic in most conditioning plants.

Principles of operation:

- Principles of air screen cleaners are based on use of aspirators or airstreams to remove light trash, dust and undesirable material larger and smaller than the crop seed.
- Top screens (scalpers) remove larger materials and bottom screens remove smaller materials than the seed.
- Machines vary in sizes, from one screen to several screens with airstreams.
- Two, three, four and five air screen models are commonly used.
- All air screen cleaners operate, by taking advantage of the major characteristics of the seed; width, size, length, shape and contact with the air stream.

Mode of operation:

Aspiration:

- Removes light material from raw seed and light weight crop seed, weed seed and chaff from the graded crop seed. The separation of the air screen cleaner is critical and it is advisable to sacrifice a few good seed to ensure good quality.
  Seed may fall directly onto a scalping screen which allows the good seed to pass through, while large foreign matter ride over and is discarded through a spout.
  Or the seed falls through an aspirating air stream which blows off the lighter material from the seed mass.

Scalping:

- Removes larger material than the crop seed (good seeds drop through screens openings while forein material rides over the screen into a separate spout.)

Grading

- Second screen is a grading screen. Perforations of this screen are large enough to allow small trash, weed seed and dirt to pass through but scalps off large material which escaped first scalping, by trappers
- Trappers are hammer-like screen knockers and brushes move back and forth underneath the screens to remove and brush away material clinging to it

Adjustment of machines for efficiency:

- For efficiency and precision the following adjustments are important in an air screen cleaner:
- The pitch of the screen.
- Rate of vibration of the screens.
- Volume of air blast.
- Choice of screens.
- Feed rate.
- Adjustment of the screen brushes.

The pitch:

- The pitch is the angle or slope the screens are set
- Careful adjustment of the pitch or slope of most machines increases efficiency of cleaning.
- Adjustments enable operator to move seed over the screen rapidly or slowly to suit the purpose.
- For better results, it is normally advisable to set the scalper screen, at a steeper pitch to hasten trash and weed seed out. As graders, bottom or grading screens are effective when set at a flat pitch to hold seed on the screen longer. This allows ample time for all small weed seed to pass through perforations.
- The pitch setting could be reversed where close separation is not required,
- The smaller the pitch angle, the longer the material takes to pass over the screen.
- This gives more time and a better chance for seed to line up with a hole and pass through the screen.

Adjusting the pitch:

- The pitch or slope in some machines can be adjusted to increase cleaning efficiency.
- The pitch adjustment enables the operator to move seed over the screen rapidly or slowly.
- When the scalper screen is set at a steep pitch, removal of trash and weed seed is faster
- Setting the bottom or grading screens at a flat pitch tend to hold the seed on the screen longer, to give small weed seed a chance to be shifted through the screen perforations.
- The smaller the pitch angle, the longer the material takes to pass over the screen.
- This gives more time and a better chance for seed to line up with a hole and pass through the screen.

Rate of screen vibration:

- Adjustment of vibration is important in order to control the action of the seed on the screens.
- Fast shake causes the seed to turn and tumble and present all sides to the screen openings
- Fast shake speeds are very effective in cleaning chaffy seed lots.
- Moderately slow shake speeds usually obtain accurately sifted seed.
- However too slow speed tends to clog screen perforations and causes poor or incomplete cleaning.

Volume of air blast:

- Air-blast should be adjusted enough to remove a few good seed.

- In every processing operation some good seed will be lost but the loss must be kept to a minimum. This ensures the removal of all light materials.

Choice of screens:

- There are different types of screens; oblong, triangular and round
- Choice of screens is most important factor affecting performance of the air screen cleaner.
- In selecting slotted- hole screens for example, be sure to select proper length, the slot in the top screen should be long enough to pass the good seed at a reasonable capacity.
- The slot in the grading screen should be long enough to let the crop ride through.
- Use of hand testing screens
- Liberal assortments of hand testing screens are always available to enable the processor to experiment and select suitable screens for each lot.

The feed rate:

- This can be adjusted by increasing or decreasing the speed of the metering roller or by varying the opening of the metering gate located in the bottom of the feed hopper. The feed rate should be regulated to keep the final grading screen about 7/8 full.
- Better to have a small section of the screen uncovered part of the time, than to flood the screen occasionally.

Adjustment of the brushes and finishing machines:

- If the brushes do not operate properly, the screen perforations will clog and incomplete separation results.
- Finishing machines are normally used for seed that has been cleaned by other machines such as the air screen cleaner.

Finishing machines:

The indented cylinder:

- Undesirable materials not removed by the air screen machine are further removed by other machines, using almost the-same seed characteristics, for making a finer separation.
- These machines consist of length, thickness and width graders, a gravity table /separator, spiral separator etc, depending on the level and type of grading required.
- Where differences in seed are marginal in terms of width and thickness air screen machine may not be very effective.
- Undesirable materials such as broken seed, soil particles and some weed seed may equally have the same width and thickness as the crop, but using the slight differences in length, enables the indented cylinder to separate the two.
- Short seeds are lifted out of the seed mass and are dropped into the lifting troughs. Long seed remains in the cylinder and are discharged out through a separate spout at the end of the cylinder.
- As the cylinder revolves, it creates a centrifugal force which helps to hold seed in the indent. Short seeds are kept in the indent until the cylinder turns to the point where the indent is inverted enough for gravity to cause the seed to fall out of the indent.
- Various sizes and shapes of indents are available**.**
- The shape, slope and depth of the indents contribute to the quality of separation.
- Indent sizes are identified by numbers; the larger numbers indicate the larger indent sizes.

Gravity separator:

- Important in separating undesirable seed and inert contaminants that are so similar in shape, size and seed coat characteristics to the crop.
- Also separates other crop and weed seed as well as some other contaminants.
- It is about the best machine for upgrading seed quality.
- Very useful for separating deteriorated, mouldy or decayed seed which are similar in size and shape to the good seed but have a lower specific gravity
- Also, insect damaged seed, empty and defective seed, heavy non seed particles such as mud balls, soil and small stones are removed because of differences in specific gravity.

Principle of operation:

- A gravity separator consists of a base/ frame, one or more fans, a plenum chamber (air chest), a porous vibrating deck, a feed hopper and a feed discharge system.
- Seeds are introduced onto the porous metal or fabric deck, where the combination of shaking and airflow up through the deck causes them to stratify according to differences in specific gravity.
- The heavier particles remain close to the deck surface while the lighter materials float on a cushion of air above them. The deck is tilted in two directions which allow the different components to separate freely to either side of the deck.
- It is normally used after cleaning when most of chaff, stems and off-sized contaminants are eliminated.

OTHER TYPES OF PROCESSING MACHINES

Debeader:

- Used to remove awns especially in grass seed before actual cleaning process.
- The seed is robbed against mechanical devices (rotating beater arm) until the appendages are removed.
- Suitable for pre-cleaning operation.

Spiral separator:

- This classifies seed according to shape and ability to roll.
- It consists of a sheet of metal strips fitted around a central axis in the form of a spiral. The seed is fed in at the top into the inner spiral.
- Round seed rolls farther down the inclined flight and obtains a higher speed than flat or irregularly shaped seed.
- The speed of the of the round seed increases until it rolls over the edge of the inner flight into the outer fight where it is collected.
- The slower moving seed does not build up enough speed to escape from the inner flight.
- Used in removing damaged seed from brassica spp, vetch, pea, and lentil

Picking belt

- A conveyor belt on which the seed is fed.
- Individual seeds are observed by a number of labourers who sit along the picking belt.
- An alternative of a colour separator is conveniently the picking belt
- Picks any material not seed and can be a pre-cleaner

Needle indented cylinder:

- A special indented cylinder in which the cylinder has a large number of needles.
- Insect infested grains/seed will be lifted from the tray as the cylinder rotates, because the needle fits into the hole made by the insect.

Belt grader:

- A belt grader separates on the basis of ability to roll or slide.
- The machine consists of a turning belt and a feeder that drops the seed onto the belt.
- The angle and speed can be adjusted.
- Smooth seed slides against the direction of rotation and rough particles, eg stalks which cannot roll easily are conveyed upwards for discharge.
- The grading is dependent on the shape, weight, surface texture of the seed and the inclination speed and surface of the belt.
- It is used to remove stalks from processed seed.

Magnetic separator:

- The magnetic separator exploits surface texture.
- When a mixture of seed is treated with iron filings, the rough seed normally picks up the iron filings but the smooth seed will not.
- When such seed is passed through a revolving drum, the seed coated with the iron filings is attracted to the drum and separates from the smooth seed.
- To improve upon the effect, water can be added while mixing, in some cases water is indispensable.
- The greater the difference in surface textures of the components, the more effective the separation.
- Magnetic separator is used to remove Stellatia media (chick weed) from clover and alfafa

Scarifier

- The purpose of the scarifier is to remove the hardness of the seed coat to improve germination.
- The seed is fed through a drum with sand paper on the inside wall.
- A scarifier is often used with lucerne or sweet **clover.**

Treatment and storage:

- Some processing plants are fitted with treatment units.
- As a last value addition, processed seed may be treated with either an insecticide, a fungicide or both as and when the need arises.
- Treated/untreated seed is packaged into a suitable packaging material that, will eliminate moisture absorption, infestation of insects and micro-organisms and rodent attack.
- All packaged seed must be properly tagged.

Storage environment:

- The storage environment must be clean dry, well ventilated and spacious to enable each lot to be easily identified.
- Seed should not be too close to the wall to avoid the occurrence of hot spots.
- Stored seed should be sampled from time to time for testing, to ensure maintenance of viability.

Mechanical contamination

- Although processing is the principal means of removing contaminants, it can also be a major source of contamination. These operations should be carried out without contaminating the seed being processed with seed of other varieties and crops.

- Genetic and physical purity are important aspects of seed quality. Genetic purity allows the transfer of true-to-type variety from the breeder to the farmer. Genetic purity is best controlled and taken care of in the field. During processing you cannot separate two varieties of the same species; but you can easily mix them.

- Physical purity indicates the level of contamination by seeds of other crops and weeds. Mechanical contamination can happen during harvesting, threshing, handling, drying, cleaning, bagging, treating and storage.

How to prevent mechanical seed contamination

- Genetic and physical purity of the seed must be protected in all operations of seed production and supply. Management during seed processing must include measures which prevent seed admixtures and ensure seed purity.

- Complete cleaning of machines between lots, between varieties, and between crops is essential. The following suggestions aid in proper sanitation between lots and help prevent accidental mixtures:

Processing plant:

- Only one variety or lot should be in the processing area at the time. Seed awaiting processing should be kept in the storage area.
- Process the early multiplication generations of a variety in the middle of the processing of the same variety in the following sequence; certified seed, basic seed, pre-basic seed and then certified seed again.
- Clean warehouses, floors, corners, ramps etc of all trash, dust and seed after each lot is processed using vacuum cleaner and compressed air.
- Begin at the point where seed enter the plant; continue cleaning in the sequence of seed flow (ramp, dump pit, elevators, conveyors, bins, then machines and floors) in the sequence in which seed would reach them.
- Use proper labels at all times.
- Use new bags.

Receiving area:

- Keep surrounding area clean.
- Clean after each seed lot.
- Clean intake hopper.

Air screen cleaner

- Clean elevators and surge bin first.
- Remove all screens and brushes. Open the feed hopper gate. Turn on power. Open upper and lower air and run machine empty for a few minutes.
- Clean exterior parts of machine with brush and compressed air.
- Inspect inside and outside of machine and all supports; remove any seed or loose debris that are lodged in any opening.
- Vacuum air chambers.
- Clean screens by rubbing bottom of screen with stiff brush to remove seed lodged in screen openings.

- Clean brushes with compressed air and sharp-pointed probe. Balls are preferred over brushes because seed lodges in the brushes and leads to mixing.
- Vacuum all debris from floor under and around machine.
- Vacuum all discharge spouts.
- Wipe off excess grease from pulleys, shaft, bearings and grease fittings.

Cylinders:

- Clean elevator and surge bin first.
- Open feed control to the maximum. Invert the lifting trough inside the cylinder; increase speed to its maximum and run machine for few minutes.
- Clean exterior surfaces with brush and compressed air.
- Clean hopper, lifting, auger, and shaft with compressed air. Remove lodged seed and debris particles.
- Clean all discharge spouts.

Gravity table:

- Clean elevator and surge bin first.
- Clean feed hopper, deck and exterior ledges with compressed air.
- Run machine for few minutes with open feeding gate, maximum air and high speed.
- Remove any remaining seed from the deck and discharge spouts.
- Clean all discharge spouts.
- Clean motor, exposed pulleys, belts, shields, and grease fittings with brushes and air blast.
- Remove air filter and vacuum out the inside of the machine. Clear filters with air blast.

Elevators:

- Open elevator boot, vacuum loose seed and debris from elevator boot and surrounding floor.
- Run elevator to dislodge loose seed.
- Inspect belt and buckets. Turn belt by hand and remove lodged seed from behind each bucket by air blast and sharp-pointed tool. place spacers between bucket and the belt; this holds bucket out from the belt and prevents seed from hanging behind the buckets
- Vacuum feed hopper.

- Where possible, use self cleaning elevators.
- Elevators should not be mounted in pits too small for clean out access. Pit should be large enough to allow the worker to get in and clean out elevator boot.

Surge bins.

- Clean inside of bin.
- Clean seed ladders.
- Open discharge gate and blow compressed air through the bin.

Labor management:

- Labor in seed processing activity is a direct operating cost.
- Therefore one or two techniques which, while not strictly involved in the actual costing of labor are related to this topic in so much as their application affects labor costs.
- This technique involves the objective and effective study of work activity in order to effect improvements.
- The operation of processing equipment cannot be complete without manual labor, and therefore it is very necessary to study the labor element in this activity by work measurement, which involves ascertaining the time it should take to carry out a specific task.
- Normally work managements should follow a method study, since there is little point in finding the time it should take to do a job before finding the best way to do it.
- In addressing ourselves to the question of labor utilization in seed processing activity, the following are good indicators of good labor management.

Supervision:

The processing officers must know the capacity of the machines in their outfit by judging their output on hourly basis.
The knowledge of the output of the mill is the yardstick to be used in measuring the daily output of the mill operators. Supervisors should find lasting solutions to the underfeeding problems of the machines

Seed flow manuals:

- The processor must ensure the smooth flow of seed, by closely monitoring the operation of the machine and ensuring the necessary adjustments and feeding.

- The processor must carefully study the machine manuals as an aid to the identification of the several parts of the machine under his control.
- The careful study of the manual can assist the processor to diagnose the flows in the operation of the cleaners and other equipment.
- Probably the major pre-requisite to safe handling of machines is a knowledge of their construction and understanding of their operation

Labor register:

- It is very necessary to keep a good roster of all workers and equipment
- This is necessary to evaluate the performance and efficiency of each individual assigned to the equipment.
- A good record on individual workers might be a perfect reference for incentive awards.

Safety rules and regulations:

- The use of seed processing machinery involves man, machine and environment to give an accident or to prevent it.
- A man, machine and environment concept is therefore necessary in designing a safe product.
- The safety of processing operators should be a major concern to processing officers.
- The machine operators must be constantly reminded about personal hygiene, ie trimming their finger nails, washing of overalls etc.
- Smoking in and around the place of work must be discouraged by educating workers about hazards of smoking especially in a closed environment.

Environment:

- The processing officer must ensure that the working environment is clean and well ventilated.
- If possible workers should be permanently assigned to oversee the general cleanliness of the working environment.

CHAPTER SIX: SEED SAMPLING AND TESTING

Purpose:

To ensure that high quality seed is made available to the seed trade, domestic and international.

- Quality seed has the capacity to produce abundant crop on the field with high yield and quality produce as the ultimate goal.
- However seed quality is a multiple concept made up of a number of attributes.
- These attributes are of interest to all segments of the seed industry.
- These segments consist of the seed producer, the processor, the warehouseman, the merchant, the farmer, the certification authority, and to the government or agency responsible for seed control.
- In all cases the ultimate objective of testing is to determine the value of seed for planting.
- As a living biological product its behavior cannot be predicted the same way as non-biological materials.
- Therefore methods used must be based on scientific knowledge and experience in seed testing.
- Also accuracy and reproducibility required depend on the type of test.
- Seed moves across international frontiers and for purposes of accuracy, reproducibility when testing is conducted in international laboratories there is the need to use standard methods and equipment.
- To achieve uniformity in seed testing, rules regulations and testing procedures are designed by the International Seed Testing Association.
- The rules prescribe the objects and principles of each test

Sampling:

- Since whole seed lots cannot be presented for testing in the laboratory samples must be taken.
- A good sample has all the characteristics of the lot.
- It is important to take a good sample to the laboratory for testing.
- A sample is a representative portion of the seed lot.
- The object of sampling therefore, is to obtain a sample of a size suitable for tests, in which the probability of a constituent being present is determined only by its level of occurrence in the seed lot.

Definitions:

- Seed lot: A specified quantity of seed that is physically and uniquely identifiable
- Primary sample: A portion taken from the seed lot during one single sampling action.
- The composite sample: It is formed by combining and mixing all the primary samples taken from th seed lot.

- Sub-sample: This is a portion of a sample obtained by reducing a sample.
- Submitted sample: This is a sample that is to be submitted to the testing laboratory and may comprise the whole of the composite sample or sub-sample thereof. The submitted sample may be divided into sub samples packed in different material meeting conditions for specific tests. (eg moisture or health tests)

Duplicate sample:
This is a sample obtained for submission from the same composite sample and marked 'Duplicate' sample.

Working sample: This is the whole of the submitted sample or a sub sample thereof, on which one of the quality tests is made. It must be of the weight prescribed by ISTA rules for the particular test.

- Sealed: this means that a container in which seed is held is closed in such a way, that it cannot be opened to gain access to the seed and closed again, without either destroying the seal or leaving evidence of tampering. This refers to sealing of seed lots as well as samples.
- There are different types of containers used to store samples with some which are self-sealing.
- After seeds are sampled and put into containers the containers labeled are marked/labeled
- A container is considered labeled when there is a unique identification mark on the container which defines the seed lot to which the container belongs.

General Principle
- As a general principle, a composite sample is obtained from the seed lot by taking primary samples from different positions in the whole seed lot and combining them.
- From the composite sample, sub-samples are obtained by sample reduction procedures at one or more stages forming the submitted sample and finally the working sample for testing.

Sampling procedures
- Seed lot must be as uniform as practicable at the time of sampling
- Where there is evidence of heterogeneity, sampling should not take place.
- Seed containers must not damage the seed and should be properly labeled before or just after sampling.

Sampling Intensity

- Seed lots in containers of 15kg-100kg(inclusive) the intensity is below.
- 1-4 containers 3 primary samples from each container.
- 5-8 containers 2 primary samples from each container.
- 9-15 containers 1 primary sample from each container.
- 16-30 containers 15 primary samples from the lot.
- 31-59 containers 20 primary samples from the lot.
- 60 or more containers 30 primary samples from the lot.

For seed lots smaller than 15kg capacity containers shall be combined into sampling units not exceeding100kg

- 16-30 containers 15 primary samples from the lot.
- 31-59 containers 20 primary samples from the lot.
- 60 or more containers 30 primary samples from the lot.

- 16-30 containers 15 primary samples from the lot.
- 31-59 containers 20 primary samples from the lot.
- 60 or more containers 30 primary samples from the lot.
- For seed lots smaller than 15kg capacity containers shall be combined into sampling units not exceeding100kg.
- Up to500kg at least 5 primary samples.
- 501kg-3000kg one primary sample for each300kg but no less than 5
- 3001-20000kg one primary sample for each 500kg but not less than 10.
- 20001kg and above one primary sample for each700kg but not less than 40.
- When sampling seed lot to 15 containers all must be sampled.

For seed lots smaller than 15kg capacity containers shall be combined into sampling units not exceeding100kg

Taking primary samples

- While maintaining the sampling intensity, it is also important to ensure the minimum amount of seed required for the requested test is sent to the laboratory and enough seed remains available for obtaining a duplicate sample if requested.
- Random sampling of seed from containers must be random and primary samples must be approximately equal in sizes.

Sampling techniques

- Primary samples must be taken from the top middle and bottom of containers.
- Seed lots are usually stored in various containers and rules are specified for taking samples in each container.
- The instruments used for sampling must neither damage the seed nor select the seed according to size, shape, density, craftiness or any other quality trait.

Methods of sampling

- Automatic sampling from a seed stream , using an automatic sampling device, or manually. however sampling must be Sampling uniform. material should not bounce back, and intervals of taking samples should be constant and random.
- stick also known as stick trier, or sleeve type trier.
- Apart from the sampling stick or trier , there are other sampling devices such as the Nobbe trier and even including sampling by hand.
- Whichever method is used will have to follow the stipulated sampling techniques.

Obtaining the composite and submitted samples.

- With a good sampling technique, a uniform composite sample is obtained by mixing the primary samples.
- The composite sample is further divided to obtain the submitted sample which is sent to the laboratory for the various tests to be conducted.
- The submitted sample is marked with the same identification as the seed lot and sealed before submission to the seed lab.

Procedures for obtaining the working sample.

- The submitted sample is further sub divided in the laboratory to obtain the working sample.
- Minimum sizes of working samples for each test, are prescribed by ISTA for the various crop species.
- In conducting these tests seed analysts should refer to ISTA rules for seed testing, which serves as a guide.

Sample reduction methods

- Reducing samples to the recommended sizes require some techniques and equipment
- Before sub-dividing to obtain the prescribed size the sample must be thoroughly mixed.
- The submitted/ working sample shall then be obtained by repeated halving or abstracting and subsequently combining small random portions.
- There are various types of equipment used to divide samples but the most common are the mechanical divider, conical divider, soil divider, centrifugal divider, and the rotary divider.

Apparatus and methods for sample reduction

- The mechanical divider: This method is suitable for all kinds of seed except chaffy seeds. The apparatus divides the sample passed through it into two or more approximately equal parts.
- The submitted sample can be mixed by passing it through the divider, recombining the parts and passing the whole sample through a second time, and similarly, a third time if necessary. The sample is reduced by passing the seed through repeated and removing half on each occasion.
- The process of reduction is continued until a working sample of approximately but not less than the required size is obtained.
- The conical divider: This consists of a hopper, cone and series of baffles directing the seed into two spouts. The baffles form two alternate channels and spaces of equal with.
- A valve or gate is at the base of the hopper. When the valve is opened the seed falls by gravity and is evenly distributed through the channels, through spouts and to pans.

Other types of equipment

- These are the soil dividers, centrifugal dividers, rotary dividers, variable sample dividers, modified halving method, the spoon method and the hand halving method. Each of these is described in detail in the hand book for ISTA. Each method may have advantage over the others depending on the type of crop seed and the test method.

Storage of samples

- The primary aim of storage of samples after testing is to be able to repeat the original tests carried out on the submitted sample.
- Therefore storage conditions should be such that seed quality traits are minimal
- For purity, physical identity must be maintained and for germination and seed health, sample should be under cool conditions.

Type of tests conducted on the working sample.

- After obtaining the working sample the following tests are usually conducted:

Type of tests conducted on the working sample.

- After obtaining the working sample the following tests are usually conducted:
- Purity, Other seeds by number, Germination, Tetrazolium, Seed health, and Species/variety testing.
- These are briefly discussed:

Purity analysis

Object:

- To determine (a) the percentage composition by weight of the sample being tested; and (b) the identity of the various species of seeds and inert particles constituting the sample.
- Definitions:
- Pure seed; This refers to the species stated by the applicant, or found to predominate in the test and shall include all botanical varieties and cultivars of that species.
- By definition, the pure seed shall include, immature, undersized, shriveled, diseased or germinated, providing they can be identified as of the species, unless transformed into visible fungal sclerotia, smut galls or nematode galls.
- Intact seeds as defined by each genus; eg florets with an obvious caryopsis containing, free caryopses as in Poaceae or pieces of seed units larger than one half of the original size.
- Exceptions for particular genera:
- For seed units of the families Fabaceae (legumes), Brasicacea (Crucifers) etc with seed coats entirely removed are considered as inert matter. Separated cotyledons as in legumes are regarded as inert matter, irrespective of whether or not the radicle-plumule axis and or more than half the testa may be attached.
- O ther criteria for definition as pure seed eg for the genera Poaceae (grass seeds) are contained in the Rules for seed testing and can be referred.

Other seeds

- These include seed units of any plant species other than of pure seed.
- For classification as pure seed the distinguishing characteristics described in the pure seed hold
- Also seeds of species which can be evaluated without necessarily blowing, using the blowing procedure.

Inert matter

- This includes seed units and all other matter and structures not defined as pure seed or other seed as follows:
- Seed units in which it is readily apparent that no true seed is present.

- Florets of those species with a floret less than the minimum prescribed size. Sterile florets attached to a to a fertile floret are to be removed except in certain genera.
- Pieces of broken or damaged seed units half or less than half the original size.
- Those appendages not clssed as being part of the pure seed in the pure seed definition for the species.
- Seeds of Fabaceae (legumes), Brassicaceae (Crucifarae) etc with the seed coat entirely removed.
- Separated cotyledons of legumes are also considered as inert matter.
- Unattached sterile floret, empty glumes, lemmas paleas, chaff stems, leaves, cone scales, wings, bark, flowers, nematode galls, fungus bodies, such as ergot, sclerotia and smut balls soil, sand stones and all other non seed matter.
- All other material left in the light fraction when the separation is made by the uniform blowing method except other seeds. In the heavy fraction, broken florets and caryopses half or less than half original size are included.

General principle

- The working sample is separated is separated into three component parts:
- Pure seed, Other seeds inert matter, and the percentage of each is determined by weight. all species of seed and each kind of inert matter present shall be identified as much as possible and if required for reporting its percentage by weight shall be determined.
- The working sample is separated is separated into three component parts:
- Pure seed, Other seeds inert matter, and the percentage of each is determined by weight. all species of seed and each kind of inert matter present shall be identified as much as possible and if required for reporting its percentage by weight shall be determined.

Apparatus:

Aids such as transmitted light, sieves and blowers may be used in separating the component parts of the working sample, eg the blower is used for uniform blowing method for species

Procedure:

- Purity is conducted using a working sample obtained from a submitted sample.
- The size of the working sample shall be either a weight estimated to contain at least 2500 seed units, or
- not less than the weight as specified for the sp in the ISTA rules.

Separation:

- First weigh working sample, separate it into component parts, following ISTA rules. Separation shall be based on an examination of each particle in the sample, in some cases special procedures such as uniform blowing method may be applied.
- After separation, each component part and any species of of seed or kind of other matter for which a percentage is to be reported shall be weighed in grams to minimum number of decimal places necessary to calculate %.

- First weigh working sample, separate it into component parts, following ISTA rules. Separation shall be based on an examination of each particle in the sample, in some cases special procedures such as uniform blowing method may be applied.
- After separation, each component part and any species of of seed or kind of other matter for which a percentage is to be reported shall be weighed in grams to minimum number of decimal places necessary to calculate %.

- First weigh working sample, separate it into component parts, following ISTA rules. Separation shall be based on an examination of each particle in the sample, in some cases special procedures such as uniform blowing method may be applied.
- After separation, each component part and any species of of seed or kind of other matter for which a percentage is to be reported shall be weighed in grams to minimum number of decimal places necessary to calculate %.

Calculation and expression of results.

- Total weights of all the components and subtract from weight of working sample.
- If there is a discrepancy of >5% retest sample.

Add together percentages of all fractions. Fractions that are to be reported as trace should be excluded from the calculation added

Reporting results:

- When the weight of the working sample tested deviates from that prescribed by ISTA rules the actual weight examined must be reported on the certificate.
- The result of purity analysis shall be given to one decimal place and the percentage of all components must total 100. Components of <.5% shall be reported as trace.
- The actual weight of seed examined, and the scientific name and number of seeds of each species sought and found in this weight shall be reported on the seed analyst certificate.

- Could also be expressed as number of seeds of each species or category of seeds per kg and certificate endorsed as COMPLETE TEST, LIMITED TEST, REDUCED TEST OR REDUCED LIMTED as the case may be.

The Germination test/ Definitions

- The essential seedling structures:
- A seedling, depending on the species being tested, consists of a specific combination of some of the following structures which are essential for its development:
- Root system; (primary root, and in some cases seminal roots)
- Shoot axis; hypocotyl, epicotyl, and in certain Poaceae/ grasses,a mesocotyl and a terminal bud cotyledons and a coleoptile as occurs in Poaceae/ Gramineae.
- There are three categories of normal seedlings.
- 1. Intact seedling, depending on the species being tested, shows a specific combination of some of the following structures:
- a well developed root system consisting of:
- a long slender primary root, covered with numerous hairs and ending in a fine tip.
- Secondary roots when produced within the prescribed test period.
- Several seminal roots istead of one primary root in certain genera e.g Avena, Hordeum, Secale, Triticum etc.
- A well developed shoot axis consisting of :
- a straight and usually slender and elongated hypocotyl in seedlings showing epigeal germination
- a well developed epicotyl in seedlings showing hypogeal germination.
- Both an elongated hypocotyl and epicotyl in some genera with epigeal and hypogeal germination.
- An elongated mesocotyl in certain genera of the Poaceae.
- a specific number of cotyledons, ie
- One cotyledon in monocotyledonsor exceptionally in some dicotyledons.

CHAPTER SEVEN: SEED TESTING AND CERTIFICATION: CONCEPT, PRINCIPLE AND METHODOLOGY

Seed quality control is a multiple concept made up of a number of attributes which comprise:

- Variety (genetic) purity
- Physical (analytic) Purity
- Physiological Quality
- Germination Capacity
- Seed Vigor
- Moisture Content
- Seed Health

Variety (genetic) Purity

- Extent/degree of purity of the variety – expressed as a percentage
- Characteristics of a variety have to be maintained through all stages of multiplication
- Seed sold must truly represent the variety named on container (variety identity)
- Best controlled in the field by inspection (examining growing plants) and tested in the field plot tests rather than dry seed in a laboratory.

Physical (analytical) Purity

- Indicates how much of the material in a seed lot is pure seed of the species named on the label
- Estimated by the analysis of a sample in the laboratory
- In the analysis, impurities are separated from pure seed
- When separation is complete, pure seed is weighed and expressed as % by weight of whole sample.

Physiological Quality

Germination Capacity

- High purity avails nothing if the seeds are incapable of germinating and producing strong seedlings in the field
- Germination capacity of a seed lot is % by number of pure seed which produce normal seedlings in a laboratory test. Weak and abnormal seedlings in any way are ignored.

- It indicates the potential of a seed lot to establish seedlings under good field conditions
- Most field conditions are not optimal
- Seed lots with higher germination capacity will always prove to establish more seedlings than those with lower germination capacity, especially under sub-optimal conditions.

Seed Vigor

- Refers to the ability ("degree of aliveness") of seed to germinate and continue growth under adverse or sub-optimal field conditions
- Seed lots of apparently equal quality as indicated by germination % will produce different responses in field emergence
- Determining vigor of a seed is as important as determining whether the seed is alive.

Factors influencing seed vigor include:

- Environment
- Nutrition of mother plant
- Stage of maturity at harvest
- Seed size
- Mechanical damage during harvesting/processing
- Deterioration caused by long storage and pathogens

Moisture Content

- Seeds are stored for periods ranging from a few months to more than one year
- Seeds should retain their germination capacity at the highest possible level during storage to ensure growth into normal, healthy seedlings
- Moisture content and storage temperature are the two factors which have the greatest effect on viability of stored seeds.
- The two factors are important because the influence respiration rate not only of the seeds but also of the fungi and other micro-organisms
- Safe moisture contents for safe storage of seeds vary with the type of crops: 12-13% for cereals, 8-10% for legumes and vegetable seeds, 8-8% for oil crops
- Moisture content of seed is measured by moisture meters and by controlled oven dry method.

Seed Health

- In certain crops, seed health is an important factor in the control of crop diseases and field establishment
- Seeds may carry pathogens like bacteria, fungi, viruses and nematodes affecting crops adversely
- A seed quality control scheme needs to set and enforce standards of seed health based on the incidence of the specific pathogen in the crop or on laboratory tests of the seed to be certified.

Seed Quality Control

- Definitions
- Objectives
- Quality Control Procedures
-

Definitions

- **Quality** – a measure of excellence of an item or product with reference to standards.

- **Standard** – reference frame for comparison.

- **Control** – imposing limitation or restriction with reference to comparison or standards.

- **Seed Quality** – a concept comprising different components broadly grouped as variety and physical purity, physiological quality, seed health and moisture content.

- **Objectives**

  To determine approval or rejection of a seed crop or seed lot in order to ensure quality

  To offer protection to procedures and consumers alike against any kind of fraud and malpractices.

- **Quality Control Procedures:**

Three procedures of seed quality control

A. Technical Procedures
B. Administrative support procedures
C. Legislative support procedures

Technical Procedures

Eligibility of varieties: two critical aspects

a) Value for cultivation and use (VCU)

- Determination of agricultural value of new varieties compared to existing commercial varieties in different agro-ecological zones across seasons
- Data from the performance trials determine whether the variety can be accepted and included in the national list of varieties

Distinctness, uniformity and stability (DUS) tests

- Tests carried out to determine whether or not a new variety is sufficiently distinct from all other varieties and sufficiently uniform and stable
- Based on DUS tests variety description is developed for use in field inspection and other purposes such as granting of proprietary rights

Limited Generation of Seed Classes

- Production of quality seed must be conducted under standardized procedures
- Succeeding crop generations progressively produce seed of lower standard but in a limited generation system defined seed production practices ensures no genetic degradation of original material occurs
- Number of generation is limited to those specified in the rules and regulations.

Minimum Field and Seed Standards

- Each seed field or seed lot must comply with set minimum standards for each class before approval can be granted
- Standards vary with crops and should be designed to maintain a proper seed supply
- They are subject to amendment under exceptional circumstances
- As a general principle standards for early generation classes must be high but realistic.

Field Inspection and Control Plots
Field Inspection

- **Purpose:**
  Confirm details on application form including correct location of seed field; verify origin of seed and identity of variety; check cropping history of the field; detect admixtures with other varieties; assess weed contamination and detect disease incidence; examine isolation requirements and general crop condition; ensure standards prescribed for the species are met.

- **Importance and desirable qualities of field inspectors:**
- Decisions on approval or rejection of a seed field should be based purely on technical grounds (set field standards); focus is the state of seed field and not the seed grower
- Field inspectors should be well trained/experienced staff, of high integrity, transparency and reliability with capacity for sound judgments and good public relations with the farming communities.

Field Inspection and Control Plots:
Control Plots

- Plots set aside for use by seed quality control system to assess performance of seed under quality control
- Seed lots under assessment are sown side by side with authentic sample of the test variety which is used as reference
- The plants are available for examination throughout the growing season, in contrast to the brief examination in a few stages in field inspection.

Laboratory Seed Testing

- Seed testing involves analysis of seed samples for quality and issuing of certificates for tested seed lots
- Analysis covers tests for many quality attributes such as analytical purity, variety purity, moisture content, germination, seed health, etc
- Proper sampling is the first prerequisite to good seed testing. Tests can only relate to the sample received and test results are as good as the representative ness of the sample to the seed lot in question.

Administrative Support Procedures

Registration of Seed Growers and Distributors

- To facilitate follow up of seeds in the production, processing, marketing and distribution chain
- Applications can be accepted or rejected depending on whether information asked for is satisfactory or not e.g. cropping history, seed source, processing and storage facilities
- Technical ability and personal reliability of applicants are important considerations.

Administration of Applicants and Certification Procedures

- Upon completion of all certification requirements, the results, approval/rejection, should be formally stated in a certificate and submitted to the parties concerned. A copy is retained for future use
- Labeling and sealing of each container/bag should be done as proof that it is part of a quality controlled seed lot.

Monitoring Movement of Seeds in Trade

- Seed movement may include taking seeds from favorable to adverse storage conditions
- It is the task of the Certification Agency to monitor movement of seeds produced within the country, imported and exported
- Inspector ensures that there are no fraudulent acts on seed quality and draws samples for retesting
- Inspector protects consumers and merchants alike.

Legislation Support Procedures

Seed Legislation is enacted in two phases

1. Seed Act by Parliament (2) Seed Rules, Regulations and Procedures by Minister

- The Seed Act – a document enacted by parliament which lays down the general principles that the seed act is to declare, purpose of seed legislation and how to achieve it.
- A seed law must be enacted to protect the farming community against fraud, negligence or accident.

Variety and Seed Rules and Regulations

- Detailed procedures for enforcing the Seed Law
- After enacting the Seed Act, the Minister of Agriculture is empowered to formulate appropriate rules and regulations

- They are put into effect and can be amended whenever necessary, to keep pace with the development of the seed programme, without taking valuable parliamentary time.

Legislative Support Procedures:

Seed Law Enforcement by Certification Agency (CA)

- After a Seed Law is enacted, certifying authorities are designated and given responsibility and legal powers for implementing the Seed Act
- Inspectors of the CA must be well facilitated to carry out Seed Law enforcement in order to be effective
- Training of inspectors essential to enforce the law.

Seed moisture content:

Objective:
The objective is to determine the moisture content of seed by method suitable for routine use. This is to ensure that seeds for storage are properly dried to maintain seed longevity.

Definition:
The moisture content of a sample is the loss in weight when it is dried in accordance with these rules. It is expressed as a percentage of the weight of the original sample.

Principle
The methods prescribed are to reduce oxidation, decomposition or the loss of other volatile substances while ensuring the removal of as much moisture as possible.

Apparatus:
The following apparatus is necessary, depending on the method used:
(a) An adjustable grinding mill
(b) Constant temperature oven and accessories which shall include containers and a desiccators
(c) Analytic balance

(d) Sieves.

Procedure:

- The submitted sample shall be accepted for moisture determination only if it is in an intact, moisture proof container from which as much as air as possible has been excluded.
- The determination shall be as soon as possible after receipt.
- During the determination, exposure of the sample to the atmosphere of the laboratory shall be reduced to the absolute minimum and, for species that do not require grinding on more than two minutes may elapse from the time the sample is removed from the container in which it was received until the working sample is enclosed in the drying container.

Weighing:

Weighing shall be in grams to three decimal places.

Working sample:

- The determination shall be carried out in duplicate on two independently drawn working samples, each of the following weight, depending on the diameter of the containers used

  Less than 8cm diameter - 4 – 5g
  8cm diameter or larger - 10g

- Before the working sample is drawn, the submitted sample shall be thoroughly mixed by one of the following:

(a) Stir the sample in its container with a spoon,

- Or Place the opening of the original container against a similar container and pour the seed back and forth between the two containers.

Cutting:

Large tree seeds (less than 5000 seeds/kg) and tree seeds with very hard seeds coats such as leguminous species may be cut into small pieces instead of ground. The cutting shall be done as a sub-sample before drawing working sample.

Grinding:

- Large seed must be ground before drying unless their high oil content makes them difficult to grind or (particularly in seed such as linum with oil of high iodine number) liable to gain in weight through oxidation.
- The grinding shall be done on a sub-sample before drawing the working.

Pre-drying:

- If the species is one for which grinding is necessary and the moisture content is more than 7% (or 10% in case of glycine max and 13% in the case of Oryza sativa).
- After re-drying, the sub-samples are reweighed in their containers to determine the loss in weight. Immediately thereafter the two partly dried sub-samples are separately ground and the ground material subjected to low constant temperature oven method or high temperature oven method.

Low Constant Temperature Method:

The working sample must be evenly distributed over the surface of the container. Weigh the container and its cover before and after filling. Place the containers rapidly on top of the cover in an oven maintained at a temperature 103± 2^{o}C and dry for 17± 1hours. The drying period begins at the time the oven returns to the required temperature.

At the end of the prescribed period cover the container and placed it in a desiccators to cool for 30 – 45 minutes.

After cooling, weigh the container with it cover and content.

High Constant Temperature Method:

The same as above except when temperature ranges between 130 to 133^{o}C, sample is dried for a period of four hours (4hr).

Calculation of result:

Constant temperature method:

The moisture content as a percentage by weight shall be calculated to one decimal place by means of the following formula:

$$(M_2 - M_3), \quad \frac{100}{(M_2 - M_1)}$$

Where:

M_1 - is the weight in gram of the container and it cover
M_2 - is the weight in gram of the container and its cover and it content before drying.

M_3 - is the weight in grams of the container cover and it content after drying.

Other Method:
Determination of moisture content by moisture meters. There two types of moisture measurements; capacitance and resistance.
FIELD INSPECTION
Recording of details of field during inspection:
Below is a prototype form for field inspectors when they visit seed fields

FORM 1: (FOR FIELD INSPECTOR)

District:……..	
Chiefdom:…….	Seed Field No:……
Ward:…….	Year:…….
Village:……..	Variety:…….
GROWER	Category to be Produced:…….
	……..
Name:…….....	Area:……Ac/Ha
Address:…….....	
Name of Inspector:	**CROP INSPECTION**
…….....	Date:…….
Signature:.....	Isolation:……..

Source of Parent Seed:……..	Crop History:.....
……	Crop Development Stage:……
Parent Seed Lot No.:……..	……..
Seed Category:……	Weeds:…….
Sowing/Transplanting Date:……..	Varietal Impurities:…….
Previous Crop (Species and Variety):……..	……..
……	Diseases Present:……..
Weeding:……	Other Observations:……..
Fertilizer – NPK:……...	……..
N:……	……..
Test Result of Parent Seed Lot:	……..
Date:……...	Recommendation:……..
Lot No.:……..	……..
Physical Purity:…….	……..
Varietal Purity:……..	……..
Red Rice:……...	Expected date of Field Inspection:……..
Other Varieties:……	Expected Date of Harvest:……
Germination Capacity:…….	
Crop declaration must be made out at every production level for which the Seed Quality Control Unit is responsible. They are made out of each seed field.	

Table 11: Standards for Laboratory Tests, A – Pre-basic Seed B – Basic Seed C – Certified Seed D Commercial Seed

Species	Purity and Lowest Value			Germination and Lowest Value			Weeds no/kg (Highest Value)**				Moisture Content	Defective Seeds % by Weight (Highest Value)		
	A-B	C1-C3	D	A-B	C1-C3	D	A	B	C1-C3	D	All classes	A-3	C1-C3	D
Maize	99.5	99.0	98.0	90	90	90*	1	2	5	10	14.0	1.0	2.0	2.5
Millet	98.5	98.0	97.0	80	75	75*	250	500	750	2000	14.0	0.5	1.0	1.5
Rice	98.5	98.0	97.0	85	80	80	1	2	5	10	14.0	1.0	2.0	2.5
Sorghum	98.5	98.0	97.0	80	75	75*	250	500	1000	2000	14.0	0.5	1.0	1.5
Wheat	99.5	99.0	98.0	85	85	85	1	2	5	10	14.0	0.5	1.0	1.5
Bean	99.5	99.0	98.0	80	75	75	1	2	5	10	16.0	1.0	2.0	2.5
Pea	99.5	99.0	98.0	80	75	75	1	2	5	10	16.0	1.0	2.0	2.5
Soya bean	99.5	99.0	98.0	80	75	75	1	2	5	10	16.0	1.0	2.0	2.5
Lucerne	99.0	98.0	97.0	75	70	60	200	250	500	1000	10.0	1.0	2.0	2.5
Guinea Grass	70.0	60.0	50.0	60	50	40	250	500	1000	2000	10.0			
Rhodes Grass	70.0	60.0	50.0	60	50	40	250	500	1000	2000	10.0			
Ryegrass	97.0	96.0	94.0	85	85	75	250	500	750	2000	10.0			
Groundnut	97.5	92.0	96.0	80	75	65	1	2	5	10	10.0	2.0	5.0	10.0
Sunflower	98.5	98.0	97.0	85	80	70*	5	10	50	100	10.0	1.0	2.0	4.0
Cotton	99.0	99.0	98.0	85	85	75	50	50	100	200	10.0	1.0	2.0	4.0
Kenaf	99.0	99.0	98.0	75	70	70	100	100	100	400	10.0	1.0	2.0	4.0

* Not applicable for f1 hybrids

** Of the following weeds, nil seed is allowed in a seed lot
Avena fatua, Avena ludoviciana (Wils oats), Cuscuta spp. (Dodder), Rotboelia exaltata (Mulungwe), Xanthium pung

CHAPTER EIGHT: SEED QUALITY CONTROL AND CERTIFICATION SYSTEMS

A THE OECD SYSTEM
B. FAO QUALITY DECLARED SEED SYSTEM.
C. ASSOCIATION OF AMERICAN SEED TESTERS

5.1 THE OECD SYSTEM

Both the OECD and the QDSS operate on the Lower Compulsory seed standards while the Association of American Seed Testers (A OAST) operate on the principle of Truthfulness in Labeling. The principle of Truthfulness in Labeling is commonly practiced where private plant breeders tend to pre-dominate the seed industry. The choice of a crop variety is based on the information provided on the label.
Most developing countries including Sierra Leone, as enshrined in the Seed Law enforces the Lower Compulsory standards. The Quality Declared Seed System, is a system recommended by the FAO of the United Nations, taking cognizance of the fact that OECD system is quite rigorous, expensive, and tends to increase seed prices beyond the reach of subsistent farmers. But subsistent farmers in developing countries constitute about 80% of the farming population. However, they both have a common goal; to supply quality seed to farmers. The OECD and the QSDS systems are briefly described below:

CONCEPT OF CERTIFIED SEED UNDER THE OECD SYSTEM
Introduction:
The system recognizes seed quality control and certification as production of a prescribed quality seed to farmers.
Therefore measures and activities must be carried out in order to secure timely production and supply of the prescribed quality seed in required quantities. To ensure that seed is of the correct quality it is necessary to monitor the different aspects and stages of the seed programme during the production cycle: breeder, foundation, certified which for seed may extend over several years.

Thus control of quality has to be built into the seed programme and must be given the prominence and resources it deserves. These resources could be financial, human and infrastructure. Failure to do so can lead to the release of seeds of inferior quality.

Seed quality control is therefore a multiple concept made up of a number of attributes each of which can be of great significance to the user of the seed, since poor quality seed may result in a poor crop or crop failure. The main aspects of quality are: genetic purity, analytical purity, germination (vigor and viability), health, size, weed seed content, appearance and storage.

Genetic quality and health status can be controlled by starting multiplication with a genetically pure and healthy stock and by ensuring that multiplication is done carefully so that admixture, undesirable pollination and infection are avoided. Analytical purity, germination, seed health and storability can be tested on samples in a well-equipped and staffed laboratory or in control plots. As shown in Table 12, several tests may be needed to ensure that seed quality has not deteriorated especially during storage.
Seed quality control systems are therefore designed to ensure that seed sold to farmers are of the right quality genetically, of good germination capacity and sufficiently pure, varietal and physical and without diseases.

ASPECTS OF SEED QUALITY

Seed quality control usually consists of three different aspects:

a) Seed testing;
b) Seed certification;
c) Seed legislation.

Quality control measures consist of field inspection, sampling and testing and pre- and post-control plots. The act of approving a seed lot for further multiplication or for sale to farmers is called certification. Certification is based on achievement of minimum field and laboratory standards (Tables 12 and 13), which in most cases are backed by legislation established and administered by Government.

ACTIVITIES

Registration of Seed Growers

For purposes of planning, location of farms for field inspection, seed sampling, testing and certification it is important that all seed growers register with the official certifying agency or authority.

Training and Education

As a first step to seed production, prospective seed growers must acquire knowledge and skills in seed production, processing, quality control and marketing. This is achieved through periodic and frequent training programmes which could be in-country, through seed tours, on-the-job training during growing periods and on the rounds of seed inspectors.

Eligibility of Varieties

Only officially released varieties, which may have been evaluated for qualities such as distinctness, uniformity and stability (DUS) and performance, are eligible for certification. Specialized institutions usually evaluate the performance of new varieties and the distinctiveness, uniformity and stability are assessed before release by an official varietal release committee.

Standards

Any quality control scheme sets standards and seed crops or seeds lots which fail to meet standards are rejected. The different aspects for which standards have to be set are indicated in Table 12 and Table13. These standards also depend on the level of the seed programme and may be lower from the outset but become more rigid as the programme progresses. Furthermore the seed quality control system has a very large role to play with regard to education of seed growers.

Generations

All the seeds produced under a quality control system, has to relate through one or more generations to seed obtained from the plant breeder. The first generation may be called basic or foundation seed. Other generations after basic seeds are called certified seed first generation or certified seed second generation. In some countries the terms registered seeds are foundation seed may be used while in others the Go is breeder seed and G3 basic seed. Restricting the number of generations is a means to preserve the quality. This is more important in cross pollinating crops than in self pollinating crops. The numbers of generations depend on:

1. the mode of reproduction;
2. the stability of the crop;
3. the risk of diseases;
4. the multiplication rate;
5. the final amount of seed required

Since during multiplication a small quality loss is expected, standards are highest for the earliest generations.

Field Inspections

Through field inspections, the genetic quality and health status and to a limited extent, the physical purity, weed seed status, etc, are controlled. Before a field is inspected, the seed source is verified via an administrative procedure where by the labels of seed and receipts of seed purchase are inspected. This administrative control is very important for the verification source; it ensures that the final certified seed relates to an authentic seed stock. During initial inspections, details on the application forms with regard to hectare planted, previous cropping and isolation distances are assessed. Thereafter during follow up field inspections varietal identity, seed borne diseases and isolation distances are assessed.

Isolation Distances

To maintain the genetic quality, the crop must be effectively isolated from other varieties of the same crop, from the same varieties in a different multiplication cycle and from crops which can cross fertilize. Also individual plants of such varieties of crops growing in the neighborhood should be taken into account. Isolation distances are very important in cross fertilizing crops because they have a substantial influence on the genetic quality. They have limited influence in strictly self pollinating crops. In crops with certain percentage of out crossing isolation distances are also important.

Varietal Identity

To establish identity the inspector must have at his disposal varietal descriptions. In some cross pollinated crops however, the inspector has to rely mainly on the administrative control which ensures that the source is correct

Time and Number of Inspections

In a well established seed control system an inspector may inspect the field without the permission of the grower. However, under our conditions where seed quality control is more educational than policing it is important to visit the field with the grower. Time and number of inspections depend on resources available but in fledgling seed industries the more the number of inspections the better.

Rouging

It is the removal of off-types, diseased plants and contaminants from the seed production field. It is also important for the inspectors to conduct rouging with the seed grower to show him what to look for and when to carry out rouging.

General Stand

Often the inspector assesses the general stand of the crop. Those weeds and admixtures considered to be dangerous or difficult to remove during processing are taken into account.

Cultural practices/Previous cropping, isolation etc

Attention should be paid to cultural practices and previous cropping especially in developing countries. Such practices include land preparation, fertilization, weed control, post-harvest techniques and assessment of yield. They are essential if the private sector is to be effective especially when seed fields have to advertise themselves.

Purity and Diseases

To check purity and diseases the field is inspected following a special walking plan as shown by sample in diagrams on Annex 5. This is to enable you to detect off-types, other crops and varieties, noxious weeds, seed borne diseases and assess general stand. Off-types are usually assessed on the basis of differences in height, shape and color. In cases of doubt more detailed observations have to be made.

Weeds and Admixtures

Only noxious weeds and weeds of other crops of which the seeds are not or very difficult to remove during processing are taken into account. However a clean weed free field is an asset especially for promoting seed of the crop. For diseases only seed borne diseases are taken into account. For diseases such as Ustilago spp neighboring fields are taken into account in setting proper isolation distances.

Seed Inspection

After harvest of the crop the production is transported to the processing plant. The seeds are inspected, deviant characters sorted out, before drying and shelling and samples are taken to the laboratory for the usual analysis.

The most important tests are physical purity, germination, moisture, varietal purity and seed health. Other tests such as vigor, viability 1000 grain weight could be carried out.

Labeling

If the seed lot is certified, each bag, container or package is labeled to prove that it is part of the seed lot. Different colors of the label connote the different classes of the seed. In some countries Yellow is for breeder seed, White for foundation seed and Blue for certified seed, but in general they all contain the same information.

Information on the label includes:

- certifying agency;
- name of crop;
- variety of crop;
- purity analysis;
- germination percentage;
- lot identification;
- date of certification;
- date of expiry;

- Code of the inspector.

Pre- and Post-Control Plots

In advanced certification schemes, pre- and post-control plots are conducted to further check on varietal identity, purity and disease occurrence. Post-control plots are not used for approval of seed lots but are only a check on the certification agency's works. They are also useful as a tool to train inspectors and they act as a warning system for problems in the multiplication fields.

Field Inspection Equipment

All seed inspectors are required to have the following:

1. a field inspection notebook (manual) into which are recorded all events noticed in the field. A copy of a field inspection manual is attached in Annex 6;
2. hand lens;
3. hand tally;
4. measuring tape;
5. raincoat;
6. Wellington boots;
7. camera;
8. map of the area;
9. sampling bags;
10. moisture tester;
11. overall
12. probe / Trier;
13. Sampling bags.
14. Meter rules
15. Rectangular (1mx0.2m)
16. Field board

Table 12: Type of Standards to be Set

Field Inspection	Seed Testing	Pre-& Post-Control
Field Preparation	Moisture Content	Varietal Purity
Planting	Physical Purity	Seeds
Cultural Practices	Germination	Seed-borne Diseases
Seed Source	Seed Health	Other Crop Seeds
Varietal Purity	Vigor	
Noxious Weeds	Other Crop Seeds	
Seed-borne Diseases	Viability	
Other Crop Seeds		
Isolation Distances		
Number of Generations		
Previous Cropping		
Stand		
Yield Estimate		
Combine Cleanliness		
Post Harvesting		
Store Sanitation		

Table 12: Standards for Field Inspection, A – Prebasic Seed, B – Basic Seed, C – Certified Seed

	Minimum Isolated Distance			Undesirable Plants			Minimum Number Inspections	
Crop	A-B	C1	C1-C3	A-B	C1	C1-C3	Field	After Harvest
Millet	20	10	10	0.1	0.3	0.3	2	2
Maize Open Pollinated	400	200	200	0.1	0.3	1.0	2	2
Wheat	10	5	5	0.3	0.1	0.3	2	1
Barley	10	5	5	0.3	0.1	0.3	2	1
Rice	10	5	5	0.3	0.1	0.3	2	1
Sorghum Open Pollinated	400	200	200	1.0	0.1	1.0	2	1
Field bean	50	25	25	0.3	0.3	0.3	2	1
Pea	100	50	50	0.5	0.1	0.5	2	1
Soyabean	10	5	5	0.3	0.1	0.3	2	1
Cowpea	10	5	5	0.3	0.1	0.3	2	1
Chickpea	50	25	25	0.3	0.1	0.3	2	1
Groundnut	20	10	10	0.5	0.1	05	2	2

5.2 SEED QUALITY CONTROL UNDER THE QUALITY DECLARED SEED SYSTEM BY FAO

INTRODUCTION

The concept of the Quality Declared Seed System was developed based on the premise that there is limited use of certified using the OECD system, attributable to high cost involved through an elaborate certification procedures. Farmers in developing countries, especially Africa and Latin America who are mostly subsistent in character and cash strapped consider seed an expensive input, especially with the alternative source provided by seed saving culture and sale of seed by the informal sector.
The QDSS is similar to the OECD system but differs in the number of times field inspections are to be conducted. It thus cuts down considerably the cost of seed certification to increase certified seed utilization. It is not a replacement of the OECD system, but can be used side by side with it.

Seed industry developments in many countries from Latin America, Asia and Africa date back to the 1960s – 1980s when most seed programmes emerged as seed projects sponsored generally by donor agencies and home governments. These projects were directly managed and controlled by the various Ministries of Agriculture or as parastatals set up and funded by the donor / governments. Seed production, processing, quality control and marketing were directly public sector functions. Seed prices were subsidized with the assumption that more seed would be bought by the farmers and therefore there would be automatic increase in crop production to engender overall agricultural development.

However studies and reviews conducted by FAO over a period of time on some seed programmes of some countries in Africa, Asia, Latin America, etc, have revealed that the anticipated increases in improved seed use did not commensurate with the subsidies. It therefore meant that the expectations of Governments in these countries in advancing their programmes through the comprehensive quality control system to increase production have not been met. At best most of the countries have only been able to meet about not more than 10% of the country's seed requirements of those crops in the formal sector and to the complete neglect of some of those staples which cannot be included in the formal system.

The review of the seed systems in the selected countries identified the following limitations in the OECD system which the Quality Declared Seed System seeks to address.

1. The OECD system is costly to operate through government budgets to the extent that if care is not taken seed will be purchased through wrong labels, repercussions of which result in the occurrence of negative consequences.

2. The system is too slow in responding to rapid relief supply situations in times of emergencies because of slow documentation

3. Tends to preclude other crops outside formal research and therefore released varieties.

4. Tends to preclude other producers, suppliers such as co-operatives, farmer groups and NGOs who may want to respond to rapid relief supply situations yet lack the financial resources to meet additional costs of formal seed quality control demands.

5. Tends to exclude traditional varieties, land races or ecotypes

The evolution of the QDS system therefore serves as an alternate system to ensure a wider coverage of the seed supply chain in terms of reduced cost in meeting quality control demands, widening the coverage of crops in the seed chain, producers and sellers and targeting the rural farmers who are generally the main source of increased crop production.

This review is also in line with current system of subsidy removal, diversification of the seed sector, evolving policies to streamline operations and ensure viability reflect the smooth operations of the seed sector and privatization which opens the door for all enterprises to have a stake in the seed industry.

The QDS system therefore operates on the basis of an open door policy which encourages the participation of other stakeholders, co-operatives, individual farmer groups and private entrepreneurs without unduly placing restrictions on them as co-players in the industry.

FAO by definition QDS is seed produced by a registered seed producer which conforms to the minimum standards for the crop species concerned and which has been subject to the quality control measures outlined in the guidelines. For seed of local varieties and varieties developed through participatory plant breeding the minimum standards may be different from varieties developed through conventional plant breeding approaches. The initial seed source shall be maintainer's seed or any class of certified seed. Some certified seed may be excluded Hybrids. However, Quality Declared seed may reproduce quality declared seed if the seed lot has been officially tested and approved.

BRIEF DESCRIPTION OF THE SYSTEM:

PRINCIPLES;

Quality Declared Seed is based on four principles:

1. A list of varieties eligible to be produced as Quality Declared Seed is established.
2. Seed producers are required to register with an appropriate national authority
3. The national authority will check at least 10% of the seed crop
4. The national authority will check at least 10% of the seed offered for sale under the designation of Quality Declared Seed.

Eligibility of varieties:

A variety shall be eligible to produce when at least one national government has included it in a list of eligible varieties following review of appropriate evidence by a national variety registration committee or equivalent institution approved by government.

In submitting a request for varietal eligibility the following information is required:

1. Name of variety
2. For a breed variety
   a) Origin of variety and the procedures used in its development
   b) Description of morphological and other characteristics, which distinguish the variety from all other varieties.
3. Define agro-ecological zone for which variety is suited
4. Procedures to be followed in maintaining the variety
5. Special requirements essential to safeguard genetic purity during multiplication
6. For a local variety;
   a) origin of variety
   b) data obtained during farmer's evaluation process
   c) description of characters which distinguish variety from other varieties
   d) agro-ecological zone suitable and procedures to be followed in maintaining the variety.

Register of seed producers
Government designates appropriate authority to register producers

Eligibility for registration
- Access to seed of an eligible variety suitable for further multiplication
- Suitable land for production or in a position to contract suitable farmers
- Nominate suitable qualified seed production staff to supervise production
- Access to suitable seed conditioning equipment and storage facility
- Access to a seed testing laboratory and trained staff

Seed production
Quality of seed shall be responsibility of the registered producer. However, quality control measures shall include the following:

1. Seed production fields have satisfactory previous cropping histories.

2. Ensure effective rouging of fields to rid of off types, weeds and diseases plants.

3. Approve only fields which meet seed inspection standards

4. Maintain identity of crop at harvest and deliver for conditioning on identified containers.

5. Maintain well variety identity and varietal purity during seed conditioning. Ensure seed at proper moisture content.

6. Serve and submit samples for tests in seed testing laboratory.

7. Keep records of all activities, i.e, inspections, test results, and completing of Quality Declared Seed declaration which is attached

Role of Government Designated Seed Inspectors to control the use of Quality Declared Seed.
You shall have the following duties:

1. Review and decide upon applications for varieties to be eligible for production of QDS; maintain an up-to-date list of those varieties accepted as eligible. Such list should include name of variety, name and address of maintainer, etc.

2. Review and decide upon applications for registration as seed producers; maintain an up-to-date register of these which are authorized and review nominations of responsible persons.

3. Ensure that inspections are made in at least 10% of the seed fields for production of QDS. Review results of check inspections in relation to standards.

4. To obtain seed samples of at least 10% of QDS offered for germination and purity and other tests as necessary.

5. Receive and store authentic samples of eligible varieties.

6. Initiate appropriate action when there is evidence that seed which does not meet appropriate standards is rejected as QDS.

Penalties
Unauthorized persons using the term Quality Declared Seed are guilty of an offence and shall be subject to:

a) Withdrawal of seed from the market
b) Withdrawal of registration or
c) Other penalties as prescribed by law.

Chapter Nine: Importance of Record Keeping

6.1 RECORD KEEPING

Record keeping is basic and fundamental in seed production as a seed grower or a company. Record keeping enables us to determine the profitability or otherwise the losses of an enterprise.
If we acquiesce to the fact that seed production and marketing a business, then it automatically means that making money is our objective. If our objective is to make money, it means that profit is our motive and therefore we are not doing business for charity. But seed production consists of a number of activities undertaken to arrive at the final product, which is seed. Since we have all agreed that profit is our motive, then we can define business as a set of activities conducted to earn a profit by providing a service or a product. In our case what are we providing? Are you providing a service or a product? As farmers we are providing a product which is seed and for that matter improved quality seed. To produce improved quality seed means investing a lot of resources. To be able to earn a substantial profit to keep us in farming it means that we must try and reduce costs, reduce risks to maximize profits.

There are four critical principles in the seed business:

- Improved inputs and practices lead to increased productivity and, ultimately profits.
- Profits are also increased through better management and informed decision making and records keeping.
- Efficiency and profits can be increased through farmer to farmer associations.
- Savings are more profitable inputs than credits.

A successful and sustainable business is the ability to pay all operational costs, fixed, variable and depreciations with a reasonable margin to continue business. To do this requires accurate information for planning and decision making. Keeping records is important because you need accurate information about your business to make good business decisions. Good records allow one to know:

- How resources are used for both fixed and variable cost items. In a business lay out, there are two types of cost elements; Fixed costs and variable costs.
- When most sales are made
- How the business is growing
- When to make purchases.

Types of records:
Two kinds of records are important:

Seasonal Records:

Records of farm operations which include: Purchases such as seed (cost of foundation seed, fertilizers, plant protection chemicals, Hired labor ,casual and permanent, transport, land rented, records of sales, purchases, tractor services, fuel etc.

Income Projections:

These are records indicating how much money you think you will make and spend over a period of time, monthly quarterly? These are generally estimates which improve over a period of time. Income projections enable you to predict the future of the business. Income projection records include sales and costs plans, cash flows.
Seasonal records are normally kept in a book called a ledger. A ledger is a book specially designed for keeping business records. Where an officially designed ledger is not available this can be improvised by using an exercise book and draw the appropriate columns. What is important is that it should contain the relevant information accurately.
The ledger should have two sections:
The most common records kept are:

1 Production records

For the contract grower/seed producer the cost items worth noting include the following:
Renting or cost of land if purchased
Cost of Ploughing /ha
Cost of harrowing/ disking/ha
Cost of seed
Cost of planting/ha
Cost of fertilizer
Cost of fertilizer application
Weeding
Supervision/certification agency
Harvesting
Shelling
Cost of pest control

Cost of chemical
Cost of packaging material
Total costs/ha
Expected Yield/ha
Cost/kg

2 **Processing records:**
Cost of drying
Cost of cleaning
% recovery
Cost of labor
Cost of chemical treatment
Cost of packaging material
Total cost of conditioning

Quality control and certification records:
Cost of reagents and materials
Cost of field inspection and certification

Marketing records
. The records can be organized under the following headings: purchase ledger, labor ledger, transport ledger and a ledger for all other costs.
Section 2; Record the amount of seed of each crop and variety you have in stock and their unit price. This is referred to as inventory control.
Section 3: record business loans if any.
Under Section 1 records can be organized into sub-sections as follows:

A Purchase ledger: shows a list of all the items you have bought for your business, when you bought them, how much you bought them, and how much you paid. This record gives you an idea of how much you may need to spend in future and can help you to predict business profitability.

Outline of a purchase ledger

Items Purchased	Date of purchase	Quantity purchased	Unit price	Total price.

B Labour Ledger

Name of labourer	Days worked	Unit price per hour	Total payment

This ledger shows a list of all hired labor, the number of days each person worked and how much he or she was paid. This record allows you to plan future labor costs, provides you with figures for your monthly projections, and helps you to decide on the amount of labor you may need. C Land Ledger

Name of Landlord	Amount of land rented	Costs per acre	Total cost

Land ledger is used to record the amount of land rented/purchased and the cost. This allows you to plan future land costs and provides you with figures for your monthly projections.

D Transport Ledger

Type of transport	Date	Quantity of seed/fertilizer transported kg/bags	Cost/bag or kg	Total cost	Destination

Transport ledger is used to record the cost of transporting seed to the market. This record helps you to predict at what time and how much money is needed for future transport costs.

E Ledger for other costs

Quantity purchased	Type	Unit cost	Total cost

This ledger is used for equipment rentals land payments or loan repayments. Also enables you to tell rapidly how much you spent on materials and labour for building a store.

SECTION 2 this relates to inventory control and sales.

An Inventory Control/Stock Control Ledger:

Records keep tract of the quantity of seed that is available for sale. This record tells you accurately at all times how much seed of different varieties you have in stock for sale. This information is important for making you aware of how much money you can make or lose depending on whether the seed is sold or not.

Date	Quantity on hand	Unit price Variety by variety	Unit price Variety by variety	Total price

Sales Ledger provide details of the name of the buyer, the date the sales was made, the quantity purchased by variety, the unit price by variety and the total price paid. This kind of record helps you to know what kind of people buy your seed, in what quantity, which varieties are most popular and where your customers are located.

Name of buyer	Date	Quantity bought			Unit Price			Total price
		Variety	Variety	Variety	Variety	Variety	Variety	

Record keeping is essential otherwise your business may fail.