Crop Production-
Level-III

Based on March, 2018, Version 3 Occupational standards

Module Title: - Selecting Agricultural Grain for Use as Seed

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East Africa Skills for Transformation and Regional Integration Project (EASTRIP

Table of Contents

G #23	LO #1- Select seed from agricultural crops

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Calculating the quantity of seed
- Calculating the area of crop needed
- Selecting a portion of the crop to be used.
- Noting the soil type in the selected portion of the crop
- Taking measures to improve seed and plant health, vigour and uniformity
- Undertaking the application of any chemicals to the crop
- Carrying out all works out using the appropriate PPE

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Calculate the quantity of seed
- Select a portion of the crop to be used.
- Note the soil type in the selected portion of the crop
- Take measures to improve seed and plant health, vigour and uniformity
- Undertake the application of any chemicals to the crop
- Carry out all works out using the appropriate PPE

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1-	Calculating the quantity of seed

1.1. Introduction

The establishment of field crops could be from seeds. The terms sowing refers to seeds while planting is used when vegetative parts are involved. The following are examples of crops established by sowing seeds: maize, groundnuts, sorghum, millet, wheat, cowpeas and melon. Crops such as yams, sugarcane, ginger, sisal, cocoyam, sweet potatoes and cassava are normally established by planting vegetative parts. A grain is a small, hard, dry seed - with or without an attached hull or fruit layer - harvested for human or animal consumption. A grain crop is a grain-producing plant. A grain is the small edible fruit of the plant, usually hard on the outside, harvested from grassy crops.

A seed is defined as an embryonic plant covered in a 'seed coat'. It is formed from the ripened ovule of plants after fertilization. The seed contains all the nutrients required to build a new plant. The two main types of commercial grain crops are cereals and legumes.

1.2. The factors affecting seed quality

Factors affecting seed quality includes the following: maturity, wholesomeness, diseases and pests and foreign matter.

a. Maturity

Immature seeds tend to store poorly, and in many instances may fail to germinate. Both the stage of maturity when harvested and the conditions prevailing during maturity are important factors in seed quality.

b. Wholesomeness

Injury, cracking or breakage of the seed would result in reduced germination. The extent to which a seed's ability to germinate is impaired depends on the part of the seed that is injured. Relatively large amounts of injury occurring in the endosperm or at the edges of the cotyledons may impair germination only slightly, while minute injury to the plumule-radicle axis may cause failure of germination. Mechanical injury to seeds may also make them susceptible to diseases and pest and therefore reduces their storability. The market value of broken but otherwise good seed is lower than that of whole seeds. Thus, wholesomeness of seeds is important, whether or not they are to be sown.

c. Diseases and pest

The presence of diseases and pests reduce the quality of seeds both for consumption and for sowing. Diseases impart an unpleasant odour and taste to the seed, while pest may consume the seed and degrade it with excrement. Diseased seeds germinate poorly and pests such as cowpea weevil may damage the seeds and also cause poor germination. Seeds that are to be stored are commonly protected from diseases and pests by treating them with appropriate pesticides. This procedure is referred to as seed dressing.

d. Foreign matter

The presence of foreign matter in the seed lot reduces its quality. Inert foreign matter such as stones and dried plant material are objectionable, particularly in seeds destined for consumption. Even more objectionable are weed seeds which may pose grave problems when the seeds are sown. Moreover, weed seeds may promote spoilage of the seed lot during storage.

1.3. Seed Certification

In each country in Africa there is an agency responsible for overseeing and supervising the quality of seeds. In Nigeria that responsibility lies with the National Seed Service. It is the duty of National Seed Service to certify seed that is intended for sowing, using most of the quality criteria discussed earlier in this unit. The activities of the agency include the monitoring of the locations where seeds is produced, grading the seeds, carrying out viability and germination tests, certifying the seeds, and in some cases distributing certified seeds.

1.4. Classes of seeds

a. Breeder seeds

This provides the source for the initial and recurring increase of foundation seed. They are directly controlled by the originator or in some cases by the sponsoring plant breeder or institution.

b. Foundation seeds

Foundation seed is the source of all other certified seed classes, either directly or through registered seed. They are handled so as to maintain specific genetic identity and purity as prescribed by the agricultural experimental station.

c. Registered seeds

These are the progeny of foundation or registered seed. It is carefully handled so as to maintain satisfactory genetic identity and purity that has been approved and certified by the certifying agency. This class of seed should be of quality suitable for production of certified seed.

d. Certified seed

This shall be the progeny of foundation, registered or certified seed that is so handled as to maintain satisfactory genetic identity and purity. Such seeds have been approved and certified by the certifying agency.

1.5. Seed Storage

The optimum conditions for storing seeds that would endure long term storage are:

a. Drying the seed to 5 -7 per cent moisture content.

b. Sealed storage in the absence of oxygen.

c. A storage temperature of 7.5° to 15°C.

Most seeds stores well in cool dry condition. However, some seed may lose viability rapidly when dry. Within limits, for most species, for each 10 per cent decrease in seed moisture the life of the seed is doubled. Likewise the life of the seeds doubles for each 10°C drop in temperatures. Most seeds can be stored at – 18°C for considerable length of time.

Seeds of some plants including citrus and chestnut should be stored moist under refrigerated condition. Moist chilling condition is necessary. To stratify seeds of many woody temperate species which help meet their dormancy requirement. If stored in relatively small quantities, most seeds should be kept dry in a tightly sealed container.

1.6. Seed rate

Seed rate is the quantity of seed of a crop that is required to sow a unit area of land for optimum crop production, and it is required to maintain optimum plant population in the field for higher yield harvest.

1.7. Calculation of seed rate

Seeding rate refers to the quantity of seeds required to sow your field or plot size, which is partially determined by the purpose of the crop (i.e. for pasture or other uses) and the farm cropping practice you plan to use (i.e. mono-cropping or mixed cropping). The knowledge of seeding rate helps you to decide the amount of seeds you need to buy for your farm. Usually seeds are packed in grams or kilograms depending on the sizes of the seeds. Since seeds are an essential input for farming, it is important to know the actual quantity of seeds that you need to obtain the correct plant population and to be able to budget appropriately.

Seeding rate, therefore, is defined as the number of seeds planted per hectare (ha) to ensure normal density of sprouts and a maximum yield. The seeding rate is expressed by the number of germinating seeds and the weight of the seeds (kg). It is determined by considering plant requirements for feeding space, the purpose of cultivation (grain, silage), soil fertility, climatic conditions and other factors. The seeding rate may differ for the same crop. The seeding rate for crops raised for silage is higher than that for crops raised for grain.

To calculate the seed rate for most of the common annual crops grown by farmers there are two methods explained and advised.

First method: Calculation based on plant population and number of seeds per kilogram

You first need to know how many seeds of each crop are contained in a kilogram. The most accurate way of calculating this is to weigh out a 100 g sample of the seed and count it.

Multiplying the number by 10 will give the number of seeds per kilogram. Otherwise, you can use below Table 1.1 as a rough guide.

Table 1.1 numbers of seeds per kilogram

Crop	**Number of seeds per kg**
Maize	2860
sorghum	44000
Groundnuts	1540
Beans	3960
cowpeas	4040

Second method: Calculation based on seed weight and likely establishment

To find the kilograms of seed needed per hectare, simply divide the number of Seeds needed (the desired plant population per hectare) by the number of Seeds/kg. Multiply this time the size of the field in hectares to get the total kilograms of seed required.

For this method, first determine the type of crop you want to grow, and identify the desired plant population per square metre (m^2). Secondly, you will need to know the weight of one individual seed in milligrams (mg). Thirdly, you will need to have an idea of the "likely establishment" rate of the seeds expressed in percentage. Utilize Table 1.2 below that shows the likely field establishment.

Table 1.2. Rate seed from a range of sowing densities and two laboratory germination percentages.

Laboratory germination (%)	Target plant population per m^2	Likely establishment (%)
95	50	95
	100	90
	200	80
	400	60
85	50	85
	100	80
	200	70
	400	50

Seed rate (kg/ha) = <u>target plants/m2 x seed weight (mg)</u>
Likely establishment (%)

For example: for a target population of 100 plants/m^2, an average seed weight of 35 mg and a laboratory germination test of 95 percent, the seed rate = 100 x 35/90 or 39 kg/ha (check the first table for likely establishment percent). For a plot size of 10 m x eight rows (at 20 cm spacing), or 0.0016 ha, the weight of such seed (35 mg) to sow per plot is 62 g.

- ✓ Seed quantity required = 39 kg/ha x 1,000 x 0.0016 ha

1.8. Importance of determining seed rate

To maintain optimum plant population in the field for higher yield harvest.

To prevent seed wastage from excess sowing such reduces the initial cost of production.

To know the quantity of seed needed for sowing in advance.

To ensure quality crop production.

Grain for consumption	Seed for planting
grain is a fusion of the seed coat and the fruit	A seed is an ovule containing an embryo
Grains are harvested for food	Seeds are planted to grow plants
Grains provide food from the fruit part	Seeds mainly provide food from embryo parts
Grains require no specific temperature	Seeds must be kept at a specific temperature which will allow them germinate and grow
A grain can s□ll be eaten when the embryo is dead	A seed will not germinate if planted when the embryo is dead
A grain need not be viable and cannot be sown as seed by farmers	A seed must be viable, vigorous and should be physically and genetically pure
A grain usually needs no certification for consumption	A seed must have passed through quality checks and be certified
A grain should never be coated with fungicides or any chemical	A seed should be coated with seed dressing chemicals such as fungicides to protect it from Pests.
Grains should never be converted to seeds	Seeds can be converted to grains and consumed provided they are not coated with poisonous chemicals
Knowing a grain pedigree is not necessary	The pedigree of seeds are very essential to trace their initial breeder seeds

Table 1.3 the difference between grain and seed

- ✓ **Generally** seed rate is the quantity of seed required for sowing or planting in an unit area. The seed rate for a particular crop would depend not only on its seed size/test weight, but also on its desired population, germination percentage and purity percentage of seed. It is calculated as follows:-

Seed rate: -
$$\frac{\text{Area to be sown in m2xTest weight of the seedx1}}{\text{Germination \%x purity\% spacing (m) x1000}}$$

Self-check 1	Written test

Name………………………………………….. ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pts each.

1. What is the difference between grain and seed
2. Explain the following terms: a. seed rate, seed quality and seed certification.

Note: Satisfactory rating - 10 points Unsatisfactory - below 10 points

Information Sheet 2- Calculating the area of crop needed

2.1. Selecting site for seed production

The site location of the farm is the most basic requirement of crop production. It is the first activity that should be considered before land preparation. The location of farm depends upon several factors.

- **Climate: -** The climatic requirements of the crop which are to be produced at the farm will decide the location of the farm. Rainfall and temperature are major elements of climate affecting crop production.

✓ **Rainfall:-** Rainfall is the most important climatic factor influencing agriculture in the tropics as it has biggest effect in farming systems, sequence & timing of farming operations. The distribution and reliability of rainfall are more crucial factors determining vegetation.

✓ **Temperature:-** Temperature is closely connected to radiation and elevation. Each crop has its own approximate temperature range, i.e its maximum, optimum and minimum temperatures for growth & flowering. Most crops make their best development between 15^{o}C to 32^{o}C. They cease growth or die when the temperature becomes either too low or too high

✓ **Sunlight: -** Sunlight is required for photosynthesis and the growth of all green plants. The amount of effective sunlight that is used by plants depends on plant type.

✓ **Photoperiod: -** Photoperiod is the daily duration of light and this changes throughout the year. At the equator the length of the day is almost constant throughout the year, but at the extreme latitudes of the tropics day length varies from about 10 hrs in winter and 14 hrs in summer. Flowering and fruiting bulbing, tuberization and seed production of certain species are affected by photoperiod crops can be classified into 3 groups on the basis of photoperiod.

a) Short-day vegetables: - plants that bloom during the short days (10 hours sunshine) are refessed short-day plants e.g. cowpea, soyabean, winged bean, potato, sweet potato etc.

b) Long-day vegetables: - The critical day length is 14 hours. e.g. Beetroot, Chinese cabbage, radish, spinach, onion etc.

c) Day neutral vegetables:- These are not sensitive to photoperiod and can be grown in any season . e.g. tomato, cucumber, asparagus, pepper, snap bean etc.

- ✓ **Strong winds, frost and Hail:-**. Windbreaks of Sesbania, and Leucocephala should be grown in compact hedges to reduce strong wind damage. The prunings of these can be used either as mulch or as animal feed. Frost, of course is not a common feature of the tropics. Where occasional light frost occurs they may be controlled by watering. Hail is one environmental phenomenon that cannot be controlled but fortunately it is rare at tropical latitudes.

- **Soil:** - The site must have soil that is good for crops. If the land is to be cropped for the first time, the fertility should be high enough to sustain crop production for 2-3 years before the farmers move away (shifting cultivation) or needs to apply fertilizers (in continuous cropping). The soil reaction should be in acceptable range with better soil texture and structure.

The relative proportion of sand, silt and clay, is called soil texture. Texture is an important soil characteristic because it affects the infiltration and retention of water, soil acration, absorption of nutrients, microbial activities tillage and irrigation. A sandy soil is easy to till but has little inherent fertility and easily loses plant nutrients with rapidly drained water. A clay soil has high potential fertility, considerable ability to retain water & nutrients, but it becomes very hard, sticky and poorly aerated when wet and so difficult to till. The ideal soils are those in which various soil particles (sand, silt and clay) occur together in desirable proportions. Main requirement of soil for growing crops are: Fertile soil, Medium clay loam or sometimes sandy loam, and well drained soil.

- **Slope:**- The land should be flat or slope gently. Land with a step slope will later create erosion problem.
- **Irrigation Facilities:**- Irrigation water should be available on the land without much difficulty. This is particularly important if continuous cropping is envisaged. The source of irrigation water may be stream which could be dammed to impound water for irrigation. In the absence of streams, underground water should be readily available through boreholes.
- **Pests:**- The presence or absence of particular diseases or pests that attack the proposed crop is also important factor to be considered when deciding on the regional location of the farm.

- **Market Facility:**- Nearness to markets or to processing faculties is another factor in deciding the regional location of the farm. This is particularly true for bulky crop, perishable crops, or crops which require processing after harvest.

2.2. Plant population

Crops thrive and perform better when they are provided with adequate space that enables them to stretch out to sunlight and when they are allowed sufficient space for root development, which means there is a reduced completion for soil nutrients and the water essential for proper growth. The space required by a plant depends on the size (both height and width) of the plant at full development stage. In addition, the space a crop is planted will also depend on whether it is sole cropping, mixed cropping or a plantation crop, and whether it is rain fed or under an irrigation system. Therefore, there are specific plant populations or plant densities for various crops.

$$\text{Plant population} = \frac{10{,}000\ \text{m2}}{\text{Product of spacing between plants (m) x spacing between rows (m)}}$$

Self-Check – 2	

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pts each

1. List the factors of site selection for seed selection
2. Define and explain site clearing
3. What is plant population

Note: **Satisfactory rating - 15 points** **Unsatisfactory - below 15 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 3- Selecting a portion of the crop to be used.

3.1. Requirements of selecting seeds

Seed is an embryonic plant enclosed in a protective outer covering. The formation of the seed is part of the process of reproduction in seed plants, the spermatophytes, including the gymnosperm and angiosperm plants. Many structures commonly referred to as "seeds" are actually dry fruits. Seed is the most important input of the crop production, be it food crop or horticultural crop. Higher crop production is impossible unless we provide sufficient quality seed in right time to our farmers particularly small and marginal farmers. Various agencies including private organizations are involved in meeting the seed demand of farmers. This booklet throws light on some important aspects of seed production in our country.

From the ancient time, the seed has been an important input for agriculture. Many plant pecies have been domesticated far away, from the region of their origin, by seeds i.e. planting material which produces the next generation. Hundred years ago farmers in general did not know the basic difference between seed and food grain. It became a tradition to save some grains or purchase some grains or exchange some grains for planting the next crop. Even now people in interior villages do the same. It was after the discovery and establishment of the "Mendel's Laws of Inheritance" that the scientists began to understand that all inputs in agriculture such as chemical fertilizers, irrigation, climatic conditions etc. give higher returns only when good quality seeds are sown.

Any part of the plant that grows into a new plant and makes a link between previous generation and present generation in broad sense is to be considered as propagation material or seed such as:

- ✓ Embryo,
- ✓ Vegetative bud,
- ✓ Leaf or stem or root cuttings,
- ✓ Seedlings produced by tissue culture, etc.

Apart from the vegetative propagation material which includes any other part I of the plant like:

(a) Cotyledons of seed grain,

(b) Seed coat,

(c) Flowers,

(d) Stems/leaves/roots are sometimes edible parts and constitute the economic produce of the crop.

It is defined as an assemblage of cultivated plants which are clearly distinguished by some characters (morphological, physiological, cytological, chemical or others) and when reproduced sexually or asexually, retain their distinguishing characters.

Seed production or maintenance of a genetic constitution of the seed is a quite specialized and scientific procedure and is not similar to general food crop production. It is important that seed of a new and superior variety should be multiplied and made available in quantities as soon as possible so as to benefit the farmers. Also the seed of released varieties must be maintained in such ways that stocks of pure propagating seed are constantly moving into commercial channels. Seed production is carried out under standardized and well organized conditions. During seed production strict attention is given to maintain the genetic purity and other qualities of the seeds.

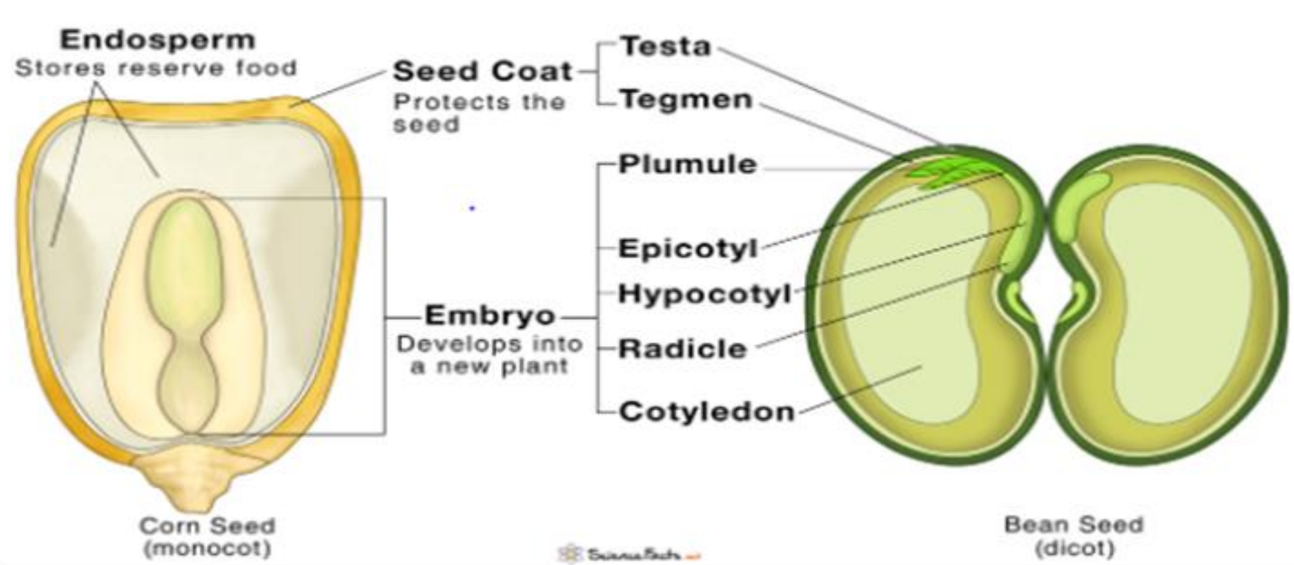

Figure 3.1 seed parts

Self-Check – 3	Written test

Name…………………………………………… ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pts each

1. List the parts of crop used seed
2. Define seed

Note: **Satisfactory rating - 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 4- Noting the soil type in the selected portion of the crop

4.1. Determinants of producing good seed

Producing good quality seed starts with a complete understanding of the protocol guiding production. The quality of seeds to be produced thus begins from the choice of seeds, the agro-ecological condition, the treatment and the cultivation practices the seed stock is subjected to. Often farmers see and could be attracted to the seeds in packages but the actual quality determination starts from the field. A poorly grown seed will do no good to a farmer who will depend on it for providing food for his family and from which s/he hopes to earn an income.

4.1.1. Soil type and climate

Soil is important as a medium for plant growth and for the support of much animal and human activity. The soil acts as a reservoir for nutrients and water providing the plants' needs for these requirements throughout their growth. The soil may also provide an environment for the breakdown and immobilization of materials added to the surface (in addition to the aforementioned plant and animal remains) such as fertilizers and pesticides and waste products such as sewage sludge, animal wastes and slurries, and composted refuse materials. The soil is a complex dynamic system in which the interactions of the biological, chemical, and physical environments results in the transformation of materials, possibly rendering initially harmful materials less dangerous and immobilizing others as a result of the interactions between these added materials and the organic and inorganic soil constituents.

This immobilization may enable breakdown of the potentially dangerous materials to less dangerous forms. These interactions and transformations may be long term, over decades, medium term over months or years, short term between individual events such as rainstorms, or almost instantaneous. Different crops require different types of soils. But most cereal crops thrive best in light- to medium-textured soils with a tolerable level of acidity/alkalinity, measured in pH. Maize prefers pH in the range of 6.0 to 7.2, although sorghum can tolerate a soil pH of 5.0 to 8.5. Groundnuts grow best in slightly acidic soils with a pH of 6.0 to 6.5, but a range of 5.5 to 7.0 is acceptable. Overall, the soil you choose should preferably be well aerated and drained for most cereal crops.

4.1.2. Basic agronomic practices for most cereal crops

For ideal growth of crops we need to understand soil types, soil acidity/alkalinity measured by pH level and level of soil fertility. We also need to consider climatic conditions such as rainfall, precipitation, amount of sun shine and recent unpredictability of weather conditions. In addition to soils and climate, it is important to carry out appropriate agronomic practices. This can be very useful when cultivating cereal for seeds. Agronomic practices for seed production should consider the following:

Adequate isolation especially for OPVs and hybrids; Proper land preparation to ensure that seeds are planted in weed free land; Spacing and number of seeds per hole to ensure that the right plant population is obtained which very much determines the performance of the plant; Timely weeding, be it mechanically or chemically. Timeliness means whenever weeds have emerged, this should be determined by the farmer which depends on the type of weeds, time of planting (whether there were no weeds when planting); Rouging; that's the removal of off-types (diseased, infested or weak/bad looking plants) to minimize contamination; and Harvesting; right timing and the handling to ensure that seeds are harvested after physiological maturity is attained and partical drying occurred already. Proper handling is to minimize contamination and reduce losses. It is important to pay special attention to the isolation distances discussed in the subsequent section.

4.1.2.1. Site selection

When selecting a site for seed cultivation, it is important to choose areas that are safe from animals and theft, and which are well suited to animal traction (ox ploughing), especially if there is a desire to expand the area under cultivation. To ensure the production of pure seed lots there may also be the need to isolate your farm either by space or by time depending on the crops grown by your neighbors.

4.1.2.2. Land preparation

This is mostly the removal of undergrowth and felling of some trees. It is advisable to undertake two separate types of tillage for land preparation: a general primary tillage and a secondary fine seedbed preparation. The tools commonly used by smallholder farmers in Ethiopia are hoes and the ox plough, while tractors are used for land preparation by large-scale farmers. For commercial purposes and on large-scale tractors implements such as disc ploughs, harrows and ridgers are used. Soil plays a key role in plant growth.

Beneficial aspects to plants include:

- ✓ Providing physical support,
- ✓ Heat,
- ✓ Water,
- ✓ Nutrients, and
- ✓ Oxygen.

Elemental nutrients, dissolved in soil water solution, are derived from soil minerals and organic material.

Self-Check – 4	Written test

Name………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 10 pts each

1. 1.Explain the relationship between soil and types of crops

Note: **Satisfactory rating - 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 5- Taking measures to improve seed and plant health, vigour and uniformity

5.1. Seed quality

Seed is a key input for improving crop production and productivity. Increasing the quality of seeds can increase the yield potential of the crop by significant folds and thus, is one of the most economical and efficient inputs to agricultural development. Seed quality is a critical aspect in agriculture as well as in the long-term conservation of plant genetic resources in gene banks. Since potential seed longevity depends on initial quality, gene bank curators need to be aware of the best management practices that contribute to the production of high quality seed during routine germplasm regeneration/multiplication. Among the factors influencing initial seed quality, those related to crop management, including plant nutrient and water supply during crop growth, climatic conditions during seed development and maturation, as well as the harvest and drying practices are of considerable significance.

- **Seeds of high quality can be obtained by:**
  - ✓ Planting in suitable areas/fields and at appropriate times,
  - ✓ Applying good crop management practices,
  - ✓ Adoption of proper harvesting and drying techniques,
  - ✓ Careful handling and processing to minimize mechanical injuries and unwanted seed mixing with other accessions, and
  - ✓ Ensuring minimum deterioration before reaching the designated storage.

However, seed production and post-harvest handling highly depend on the biology and agronomy of the species. As germplasm collections contain a wide range of diversity for morphological and agronomic characters and that there might well be critical gaps in knowledge among gene bank staff or about the species in question, gene banks may also need to embark on research to gain crop specific knowledge on optimal seed production procedures to improve seed quality.

Good quality seeds basically mean the most competent seeds, which will definitely give rise to a healthy plant, which would bear more healthy seeds. Apart from just the looks, seeds are also tested for their efficiency in germination (how many seeds from set of 100 would grow in plants when sowed.

5.2. Conducting appropriate pre-seeding treatment

- Factors influencing seed emergence
  - ✓ Temperature,
  - ✓ The time to germination,
  - ✓ The sowing depth,
  - ✓ The nature of the soil and the
  - ✓ Vigor of the seedling.

Time to emergence is usually short if germination is rapid, the temperature is moderate, sowing depth is shallow, seedling is vigorous and the soil is light, loose and free of crust. The final percentage emergence is the percentage of seeds sown that eventually emerge. It is this percentage that determines the nature of the stand obtained. If the percentage is low, the stand is poor and irregular and the farmer may consider replanting.

- **Causes of poor emergence**
  - ✓ Poor germination
  - ✓ Very low seedling vigor
  - ✓ Sowing at too great a depth
  - ✓ Attack of diseases and pests
  - ✓ Extremes of temperature which may severely retard the growth of seedlings
- **Importance of uniform emergence**
  - ✓ It ensures that all the plants on the field are at approximately the same age.
  - ✓ Operations such as fertilizing and harvesting which depend on timing can be programmed.
- **Seedling Vigor**

The seedling vigor assessment is an indication of the health of the seedlings and of the likelihood that they will yield well.

Factors that may lower seedling vigor include the following:

- ✓ Small seed size.
- ✓ The presence of pathogens in the seed or in the soil.
- ✓ Protracted storage of the seed.
- ✓ Adverse environmental condition during germination.

5.3. Characteristics of Good quality Seeds

The important characteristics of good quality seeds are as follow:

- ✓ The seed should be pure (true to type)
- ✓ It must be viable, the germination capacity up to the standard
- ✓ It should be matured, well developed, uniform in size, shape, color, texture, and look
- ✓ It should be healthy, clean and free from inert matter, such as pieces of crushed rocks, dirt, grit, soil, clods, chaff, husk etc.
- ✓ It should be free from other crop seeds and noxious or objectionable weed seeds
- ✓ It should be free from any insects and seed-borne diseases
- ✓ It should be whole, not break, crushed, peeled off, shriveled rotten etc.
- ✓ It should contain the required amount of moisture.

- **General ten steps required for producer to produce their own good seed**

- ✓ Select a fertile field.
- ✓ Use clean, good quality seed.
- ✓ Plow, puddle and level the field well to control weeds and improve water management.
- ✓ If transplanting, plant young (15−20 d) seedlings from a healthy, weed-free nursery at two per hill at 22.5 cm x 22.5 cm spacing.
- ✓ Apply balanced nutrients (Nitrogen, Phosphorous, Potassium, Sulfur, and Zinc) as per crop demand.
- ✓ Keep the crop free of weeds, insect pests and diseases.
- ✓ At maximum tillering and flowering, rogue off-types (by plant height, appearance, flowering time, etc.) and poor, diseased or insect damaged plants, or plants with discolored panicles.
- ✓ Harvest at full maturity and 20−25% moisture content (80−85% of the grains are straw-colored).
- ✓ Thresh, clean, dry (12−14% moisture content), grade and label the harvested seed.
- ✓ Store the labeled seed in sealed clean containers placed in a cool, dry, and clean area.

Self-Check – 5	Written test

Name………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pts each

1. what is seed quality and its factors
2. list all steps required for producer to produce their own good seed

***Note:* Satisfactory rating - 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 6-	Undertaking the application of any chemicals to the crop

6.1. **Requirements of using chemical in crop seed production**

Seed treatment refers to the application of certain agents physical, chemical or biological to the seed prior to sowing in order to suppress, control or repel pathogens, insects and other pests that attack seeds, seedlings or plants and it ranges from a basic dressing to coating and pelleting. Seed is a basic and vital input for sustained growth in agricultural productivity and production since ninety percent of the food crops are grown from seed. The role of seed in agriculture sector is of prime importance in developing countries like India where the population and GDP (Gross Domestic Product) considerably depend on agriculture sector.

The seed-borne and early season diseases and insects create devastating consequences if not managed timely. Emphasis on present day agriculture is to produce more with lesser land, water and manpower. The age old environmental friendly disease management practice like sanitation, crop rotation, mixed cropping, adjustment of date of sowing, fallowing, summer ploughing, green manuring composting etc. To combat plant pathogens have already lost their acceptability and are being reevaluated as a component of integrated pest management. The chemical control via soil/foliar application has its limitation affect on target organisms, development of pest resistance, resurgence of pests, pollution of food and feed, health hazards, toxicity towards plants and animals, environmental pollution etc .

6.1.2. General Selection Criteria

- **It include**:

✓ Fitting well in to the useful period of the raining season
✓ High and stable yield
✓ Resistance to insect pests and diseases
✓ Uniform heading and fruiting
✓ Moderate one thousand grain weight
✓ High oil, protein or starch content. It all depending on the purpose of your production

6.2 Securing Good Quality Seeds

Broken seeds that contain the embryo germinate less, have higher seedling mortality, and produce smaller plants than whole seeds. Breaks in the seed coat of cereals are deleterious to germination, injury at the embryo end being most serious. Broken or cracked seeds mold more than do whole seeds.

- **Causes of seed damage are:**

✓ **Mechanical damages:** They happen during harvesting, handling, and storage, when the people are not careful.

✓ **Occurrence of fungi:** The viability of seeds may be destroyed quickly by molding or heating as a result of the growth of fungi and bacteria on damp seeds stored in a warm place. The organisms utilize the food materials in the seeds, thus starving the young sprouts, and certain organisms even invade and kill the young sprouts. Seed-borne and soil-inhabiting organisms often prevent seedling emergence.

✓ **Damage of insects:** Seeds must be protected from insect pests. Damage of insect pests to seeds sometimes is more serious than mechanical damages.

6. 2.1. Good Quality Seeds

Importance: Good quality seed (high-quality seed) is an important factor in producing high-quality crops, and a foundation of high and stable yield.

Seed quality: The quality of seed is governed by its purity, viability and germination capacity. If seed lacks any of the characteristics it may become unfit for sowing.

6.2.2. Seed Treatment

It is the process of applying physical, chemical or biological treatment to the seed to keep it viable and healthy. Physical treatments include subjecting seeds to solar energy exposure, immersion in conditioned water etc. Chemical treatments include treating seeds with fungicides, insecticides, nematicides etc. Biological treatments include treatment of seeds with microbial cultures such as that of Rhizobium.

- Seed treatment has some advantages over other pest control or crop enhancement measures such as:

✓ More alternatives available to chemical in effective manner.

✓ Protection of seed during storage and after planting in soil.

✓ Reduction in initial inoculum.

✓ Minimize the environmental side effects viz.

- ✓ Reduce risk to non target organism,
- ✓ No problem of drift and reduction in land surface exposed to active ingredients with maximum efficacy reduce the rate of application per hectare, thus decrease the cost of disease control per ha while achieving exceptional control of seed borne, soil borne and foliar diseases.
- ✓ Increase seed vigour which is the key of successful field emergence and establishment. • Even and uniform application of the chemical.
- ✓ Combination of treatment can be applied more precisely.
- ✓ Breaking of seed dormancy and improve emergence and plant stand.

6.3. Type of chemicals used for seed treatment

- There are two types of chemicals used for seed treatment:
- ✓ **Insecticides:** Parathion, phorate, chlorphriphos, furadan, dime thoate, oxidimethoate.
- ✓ **Fungicides:** Thiram, thiophante (topsin), carbendazim, thiadimefan, triadimenol, duintozene, diazoben (Dexon), carbonxin (vitavax).

6.3.1. Seed Treatment Procedures (Methods)

1. The infestation of insects, pests and diseases can be prevented by sun drying, sieving and by mixing inert material such as sand, clay, ash etc. This can also be done by treating or coating the seed with calcium phosphate, mercuric compounds, dried Neem leaves, tobacco, lime etc.

2. The infested seeds with insects, pests, germs and diseases can be made free by dipping, dressing or coating the seeds with fumigation. For soil insect pests like termites the seeds may be treated with endosulfan. For seed-borne, diseases seed may be treated with organo mercurial compounds. The stored seeds may be fumigated with phosphotoxin or methyl bromide.

3. To induce higher germination the seeds may be soaked in water before sowing, or may be exposed to warm temperature. Early rooting may be induced by treating seeds with IBA (Indol butyric acid) or GA (Gibbrellic acid) solutions.

4. To fix atmosphere N in the soil the seeds may be inoculated with symbiotic bacteria like Rhizobium or free-living bacteria, viz. Azotobacter and Azospirilleum. Similarly, to release soil phosphorus the seeds may be inoculated by phosphobacterin.

5. To facilitate sowing and induce better germination in cotton seed, they should be treated with sulfuric acid or cow dung.

6.3.2. Seed Handling: Seed handling is the procedure of drying, cleaning, grading, transporting and storing seeds.

- Care to be taken during drying seeds:
  - ✓ Temperature is controlled under 40ºC
  - ✓ Don't dry seeds too fast
  - ✓ Don't make seeds over dry
  - ✓ Operate carefully and avoid mechanical damage to seeds
- Conditions of good storage:
  - ✓ Low seed moisture content (Table 6.1).
  - ✓ As low a temperature as possible should be maintained by installing exhauster and air conditioner
  - ✓ Low relative humidity in store house by installing moisture absorption machine
  - ✓ Effective pest control.

Crop	Moisture content (%)	Crop	Moisture content (%)
Wheat	13.0	soybean	12.0
Barley	13.0	Broad bean	12.5
Maize,	14.0	Ground nut	10.0
Sorghum	13.5	cottonseed	9.5
Millet	13.5		

Table 6. 1 Seeds moisture content for safe storage

Self-Check – 6	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pts each

1. Define seed treatment
2. Explain its purpose

Note: **Satisfactory rating - 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Information Sheet 7- Carrying out all works out using the appropriate PPE

7.1. Controlling of existing hazards

The establishment of field crops could either be from seeds or vegetative parts. The terms sowing refers to seeds while planting is used when vegetative parts are involved. The following are examples of crops established by sowing seeds: maize, groundnuts, sorghum, millet, wheat, cowpeas and melon. Crops such as yams, sugarcane, ginger, sisal, cocoyam, sweet potatoes and cassava are normally established by planting vegetative parts.

PPE, as defined by the Occupational Safety and Health Administration, or OSHA, is "specialized clothing or equipment**,** worn by an employee for protection against injury by blunt impacts, chemicals, infectious materials etc."

7.1.1. Selecting suitable personal protective equipment (PPE)

PPE is defined in the regulations as 'all equipment (including clothing affording protection against the weather) which is intended to be work or held by a person at work and which protects him against one or more risks to his health or safety.

Example:-

- ✓ Safety helmets,
- ✓ gloves,
- ✓ eye protection,
- ✓ High visibility clothing (Over all).
- ✓ Safety footwear and safety harnesses.
- ✓ Hearing protection and respiratory protective equipment

Provided for most work situations are not covered by these regulations because other regulations apply to them. However, these items need to be compatible with any other PPE provided. Wear leather boots with ankle protection. *For utility line clearance work*

Wear gloves to protect against cuts, vibration, cold, harmful vegetation(thorn)

Purpose of PPE

The purpose of PPE is to reduce employee exposure to hazards when engineering controls and administrative controls are not feasible or effective to reduce these risks to acceptable levels.

Personal protective clothing and equipment include:

- **Foot protection:** Workers must wear closed-toe shoes at all times to protect feet from chemical spills and sharp objects.
- **Eye protection:** Use safety glasses for minor splash hazards, goggles for moderate hazards, and goggles combined with a face shield for severe hazards.
- **Hand protection:** Hand protection is indicated for the possibility of severe cuts, lacerations, or abrasions, punctures, temperature extremes, and chemical hazards.
- **Body protection:** Protective clothing includes lab coats, smocks, scrub suits, gowns, rubber or coated aprons, coveralls, uniforms, and pierce-resistant jackets and vests.
- **Head protection:** Hard hats must be worn by electricians, construction workers, and any other workers when there is a danger of objects falling from above.
- **Hear Protectors:** Hearing protectors come in two forms: plugs and muffs. Hearing protectors should always be considered “personal” equipment and should not be used by other individuals, except for muffs that are adequately cleaned and sanitized.

Key Points about PPE

- ✓ Do before going to worksite
- ✓ Use carefully – don’t spread contamination
- ✓ Remove and discard carefully, after finishing work
- ✓ Immediately perform hand hygiene

Self-Check -7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention all PPE and their use? (5 PTS)
2. Explain the importance of each?(5)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

LG #24	LO #2- Evaluate and grade seed

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Assessing after harvest, the grain variety saved for its suitability
- Sourcing Information regarding new varieties or trial results and progress
- Grading the seed to the required size either on or off-site.
- Applying fungicidal and insecticidal dressings
- Taking, preparing and forwarding test samples
- Keeping updating and maintaining records
- Forwarding the records kept to the appropriate person

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Assess after harvest, the grain variety saved for its suitability
- Source Information regarding new varieties or trial results and progress
- Grade the seed to the required size either on or off-site.
- Apply fungicidal and insecticidal dressings
- Take, preparing and forwarding test samples
- Keep updating and maintaining records
- Forward the records kept to the appropriate person

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1- Assessing after harvest, the grain variety saved for its suitability

1.1. Introduction

The average post- harvest losses of food crops such as *Teff, Sorghum*, *Wheat* and *Maize* have been estimated 12-9%, 14.8%, 13.6% and 10.9% respectively. A loss of 19.6% is recorded due to insects and moulds on pulses. Losses after harvest are a major source of food loss. Farmers growing horticultural crops are facing high economic loss, because there have no means of increasing the shelf life of these crops. Besides the country is not getting foreign exchange from horticultural crops due to the low levels of post- harvest technology, which makes the product of inferior quality and has no chance of competing in the world market. There are no enough processing plants and the country is losing foreign currency for importing these processed products.

The handling, processing and preservation of crop produce at the time and after harvesting may be identified as "Post- harvest management". Improved post harvest management depends on the quality and efficiency of handling, processing and preservation techniques used. Thus whether the gains in crop yield is marginal or significant; it could be nullified because of inappropriate or unreliable post- harvest management employed. Moreover, proper storage also helps to ensure household and community food security until the next harvest and helps producers not to sell at low price during the glut period that often follows a harvest.

1.2. Post –harvest operation of grain crops

Although losses in grain crops may start harvest period and extends to post –harvest period, in this section we focus on post –harvest operations. The harvested produces should properly pass through different stages of post harvest operations like threshing cleaning grading, drying, transportation, storage and, etc.

Threshing / shelling

Threshing/shelling is the operation of grain kernels from ears, heads or straw. For proper threshing /shelling the moisture content of the grain should be between 12 and 18% after grain has been separated from the straw or ear. Prior to storage or processing additional drying may be necessary. Threshing /Shelling may done manually or mechanical

In Ethiopia, traditionally, the most common system of shelling maize is by removing the grain by hand this practice is very slow, tedious and laborious. However, this method has an advantage of not breaking the grain kernels and provides the opportunity to sort out any damaged (rotten, shriveled, and discolored) grain at the same time.

Most of the time this method could not completely separate the grain from the straw, i.e., either grain is wasted with the straw or the residue is left with the grain in which insects hide themselves to damage the produce during storage.

Sorting

Sorting in the case of maize, sorghum and the like is the process of separating, molded or infested or otherwise damaged ears or heads from the healthy ones before shelling or threshing is started. For instance some maize ears which their husks open at the tip are susceptible to fungal and insect attack unless this diseased or infested ears are separated before shelling , the damage will be spread to healthy grains and will accelerated and the loss in the storage could be sever. Damaged heads or ears of crops need to be sorted out from sound and healthy in order to attain safe storage condition of the product.

Drying

Drying is the removal of moisture from the material to prevent the development of favorable environment for h the growth of moulds and insects that normally causes spoilage of the grain. Grain must be dried to safe moisture content before storage. Drying is necessary after harvesting because certain grain such as corn is difficult to dry in the field to desired moisture before harvesting**.**

In Ethiopia traditionally, small farmers, after harvesting crops, they leave the harvested crop in the field either horizontally lying on the ground in the case of teff, wheat and, barley or vertically grouped together for maize from 2 to 6 days to lose moisture.

This practice usually exposes the crop to termite attack, animal damage or theft and sometimes to wild life. Improved drying facility is therefore must be assessed and demonstrated to farmers so that drying operation would be safe and economical by saving their crop from damage. For e.g. (1) concrete made dry floor (durable hygienic provides fast drying, multipurpose use); (2) Raised platform to dry unshelled / Unthreshed crops.

Drying techniques

There are two systems of grain drying :

1. Sun drying (Natural systems of drying)
2. Mechanical drying (artificial methods of drying)

In the drying process of heat is used to evaporate the moisture from the grain and moving air to carry away evaporated moisture. It is through drying that optimum moisture level required for safe storage is maintained. The optimum moisture level required for safe storage depends or grain types, climatic and storage situations. Grains can be stored beyond three months with the moisture content of 12-12.5%. Based on mode of heat transfer drying methods are classified in to three types; (1) conduction drying (2) convection drying (3) Radiation drying

1. **Conduction drying**: Heat is transferred to the wet solid mainly by conduction through solid surface (Normally a metal) .the vaporized water is removed independent of heating media.
2. **Convection drying**: this method of drying is the most popular in grain drying Heat is transferred to wet soil by convection drying agent (hot gases) used to supply heat and carry away the vaporized moisture.
   - ✓ Under natural air drying, the unheated air is utilized for drying the grains.
   - ✓ This method is generally used in the farm level for drying grains for short term – storage. However, for large quantity, heated air is used to dry the grains at short span of time.

3. **Radiation drying**. Sun drying is an example for radiation drying the radiant energy is absorbed by the grains and transferred in to heat energy.

Cleaning

Cleaning – is the “art and science of removing matters out of place”.

Cleaning operation:

- ✓ Improves quality of produce
- ✓ Gives better storability and
- ✓ Gives high crop grade by removing unwanted materials from the produce : Like:
  - ❖ Noxious or poisonous seeds ,
  - ❖ Insect pests ,
  - ❖ Foreign materials which,
  - ❖ Encourage ,
  - ❖ fungi development,

- ❖ Reduce aeration of the produce and
- ❖ Make insecticides less effective

The methods of cleaning depend on the difference in the size density and appearance of the grain and contaminants. Therefore grains can be cleaned in different methods.

A. Using sieves of different sizes.

- ✓ The sieve which is mostly used for cleaning purposes uses the criteria of difference in size of grain and contaminants.
- ✓ Sieves of different size as per need may be used to clean grain from chaff.
- ✓ For small seeded crops, bigger sized sieves should be used which allow the seeds to go down or pass through the sieve and the chaff remains in the sieve

B. Winnowing (air cleaning)

- ✓ Winnowing is commonly done after threshing
- ✓ It is the process of separating grains from chaff
- ✓ Generally, it is done when wind is blowing because husk or chaff is lighter than grain chaff is blown away and grain separated.
- ✓ It is based on the difference in density of chaff and grain.
- ✓ Bay this method heavier particle, such as sands and stones are not easily removed.

C. Using cleaning machines

- ✓ When wind velocity is not adequate, artificial means are used to create a sufficiently strong air blast. The machine is known as winnower which may be operated by and pedal or power.

Self-Check – 1	Written test

Name………………………………………… ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pts each

1. Explain post harvest
2. List the different activity included under post harvest managements

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

2.1. Deterioration of Crop Varieties and Prevention Methods

The main objective of seed production is to produce good quality and genetically pure seeds. But during seed production due to certain reasons the genetic purity of the seed may be lost, this is said to be deterioration of a particular crop variety. Some of the reasons for crop deterioration are discussed below:

2.1.1. Developmental Variation

When a seed variety is grown in different agroecological conditions than its natural one (i.e., different environment, different soil and fertility conditions and altitudes) for several consecutive generations the developmental variation may occur. Each and every seed variety should be grown in an adaptable area to minimize the developmental variation. If at all it is grown in non adaptable areas, multiplication of nucleus and breeder seeds should be carried out in an adaptable environment.

2.1.2. Mechanical Mixtures

This kind of deterioration may take place at any stage of development from sowing to processing. It may arise through the contamination of the field due to volunteer seeds, use of the same seed drill for two different varieties, growing different varieties adjacent to each other, using of unclean threshing floor and processing unit. To avoid this kind of mixtures, utmost care should be taken at all stages of seed production.

2.1.3. Natural Crossing

This is possible in the case of sexually propagated crops. The extent of contamination depends upon the breeding system of the variety, isolation distance and its pollinating agent. Increase in the isolation distance minimizes the extent of

2.1.4. Type of seed variety

There are also different seed varieties, most of which are from plants growing in the wild and identified through natural selection, or which could be a product of the breeding in the lab, experimental fields, research plots or farmers' fields. Seed varieties are categorized broadly as land races; open pollinated, hybrid, F1 hybrid and biologically modified seeds.

- **Land races (traditional varieties)**

Land races are seed varieties that are indigenous to many locations and areas. They are often indigenous to zones or regions in which they are used. In South Sudan, there are many sorghum varieties believed to be wild and indigenous as the origin of Sorghum is partly traced to this region. Land races could also be improved seed varieties that were introduced many years ago, that have completely adapted to the local environment and for which many generation of farmers may not remember when they were first released. In most cases these seeds are often called by local names and have local characteristics to the extent that farmers trust and are often attached to them. These are also called farmers' seeds. Many of the traditional seed varieties depend on natural selection in the fields. Here farmers look for desirable qualifies which could include vigour of growth, colour, disease free or tolerant, and speed of growth and whether they are pest free or tolerant to pest attack.

- **Open Pollinated Varieties (OPVs)**

These are varieties of seeds produced by controlled natural processes through pollinating agents such as wind, birds or insects. With open pollinated seeds, the natural processes are controlled to ensure that pollen grains from a specific male plant variety are deposited on a similar female plant variety through winds, birds and or insects without contamination. The only difference is that it occurs in a controlled environment in the field which is o□en isolated (read more about isolation below). In the wild there is no way of controlling how many pollen types from a male plant land on a female plant. Even though seasons could be clear, nature also has its own risks of either starting earlier or coming late in the year. Therefore the outcome of any cycle of fertilization is unknown and the products from such fertilization processes cannot be predicted, thus making the fertilization sequence tricky. Therefore, in open pollination, farmers and agriculturists control the cross-pollinating process so that two of the same varieties of plant are guided to cross through natural agents.

The key aspect in guaranteeing proper control is to ensure isolation and to have the skills for selecting seeds with vigour and the characteristics desired by farmers. When this happens and it is successful, the result of the cross-pollination is that the plants are naturally mixed but very similar. The seeds originating from this guided process are called and marketed as open pollinated varieties or OPVs. Experts skilled in working with farmers or on research farms have produced good seeds by proper isolation. There are OPVs that are high yielding, and many are either tolerant or resistant to a set of pests and diseases.

The advantage of OPV seed is that it will produce the same type of plant as its parent, even if the plant gets pollinated by a different representative of the same variety. Yield is usually a lot higher than those of the wild varieties and, even more important to smallholder farmers, is that the OPV seeds can be collected by farmers, processed, stored, planted, harvested and planted again over a relatively long period (between 3-5 years) if the conditions are right and the seeds are well handled. Many varieties of open pollinated sorghum, maize and rice seeds have been officially released in Ethiopia.

- **Hybrid seeds**

Hybrid seeds are increasing in popularity across Africa and in the East African region. Unlike the open pollinated varieties, seeds are described as "hybrid" when a plant variety is developed through a specific and carefully controlled cross of two parent plants. Usually, hybrids are produced by the cross-pollination of male with the female parts of parents of the same species. The selected crop varieties could be inbred lines like the open pollinated. In other words the difference between a "hybrid" seed and an open pollinated seed is that in hybrid varieties the pollination of the two plants from the same species are guided, directed and controlled to cross by human intervention.

The yields from hybrid varieties are much higher than the open pollinated types, although hybrids require a relatively higher input. Hybrid seeds can be shared as farmers' seed over a shorter period of time before it begins to show decrease in yield. Note that not all hybrids seeds can be kept by farmers for replanting.

Self-Check – 2	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 10 pn'ts

1. List and explain types of seeds

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Information sheet 3. Grading the seed

3.1. Principles of Seed Conditioning

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. The vital role of planting only quality seeds and planting materials in obtaining high yield cannot be over emphasized. Seeds germination, emergence, and vigor depends on using seeds and planting materials of superior quality as well as appropriate cultural practices such as seed dressing with appropriate chemicals, time of planting, depth of planting, rate of seeding, spacing and position of seeds and propagates in relation to land preparation practices.

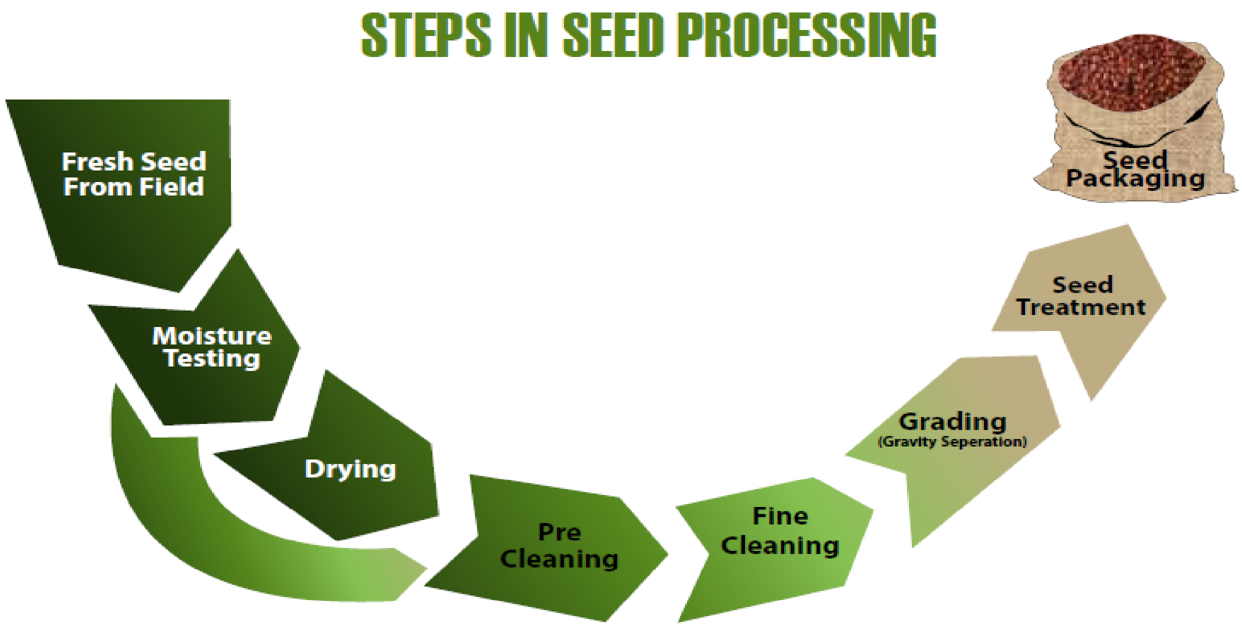

Figure: 3.1. Procedures of seed processing

Seed processing is a post-harvest activity. It is a process that involves the preparation of seeds for market and for farmers' use by removing all unwanted materials from a seed lot. Seed processing is very crucial for certification, and it is important for attracting good prices in the market. The process ensures that seeds are separated from inert materials, common weeds seeds, noxious weed seeds, deteriorated seeds, damage seeds, other crop seeds, other varieties of seeds and off-size seeds. There are various levels of processing. Simple or basic seed processing can be done by small holder farmers in a less complicated situation, while industrial level seed processing requires a highly mechanized system of seed processing. Industrial processing is o□en done through the use of specialized equipment and can be highly scientific.

3.1.1. Seed cleaning by winnowing

Winnowing is a basic technique of cleaning dry seeds. It ensures that seeds are cleaned based on their differences in specific gravity. It is usually done by hand using a tray or a fanner. It is best done where there is wind. The seeds, along with chaff, are allowed to drop from a height of several feet (about shoulder level of an adult) with the wind blowing. As they drop with the wind blowing gently through them, the seeds are separated from chaff and other light unwanted materials. With some skill and the wind, the clean seeds will fall closer onto a sheet, tarpaulin, mat or container while the chaff will fall further away because seeds are heavier than the chaff.

Figure 3.2. Seed winnowing

3.1.2. Grading and sorting of seeds

Seeds are further made cleaner through grading and sorting. This stage involves the use of at least two sieve sizes, with one slightly larger than the other. The two sieves are placed over each other. The first will allow anything smaller than the desired seed size to pass through, while the other will hold the seeds with the larger size.

Figure 3.3.seed grading

Self-Check – 3	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 10 pn'ts

1. Explain the principles of seed processing
2. Define and explain seed grading and sorting

Note: **Satisfactory rating – 20 points** **Unsatisfactory - below 20 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Information sheet 4. Applying fungicidal and insecticidal dressings

4.1. Dressing Seeds with Chemicals

a. Only use them with clean dry grains: The seeds dressed with insecticides will be stored for a long period before being sown. The seeds must be clean and dry, in order to keep the high percentage of live seeds that will germinate.

b. Selection of insecticides: The kind of insecticides for fumigating may be used for stored seeds. This type of insecticides may kill many kinds of pests in storehouse by the releasing toxic gas. Commonly used as follow: e.g. Phosphotoxin, and Methyl bromide.

4.2. Seed Disinfectants

a. Types of seed disinfectants:

- ✓ **Fungicides:** Dexon, Topsin, Topsin-M, Tuzet, Bavistin, etc.

  For seed dressing: Fungicide: seed= 0.3-1.0: 100

  For seed soaking: Fungicide: water=1: 500-1000

The time of treatment depends on kind of crops and fungicides, and concentration, normally from 10min. to 48h.

- ✓ **Insecticides:** such as Thimet, Furadan, Chlorphriphos, etc., used for seed dressing. The quantity of usage is based on the insecticide but every seed should be coated with well-distributed insecticides. Phoxin, dimethoate, oxidimethoate, etc., are used for seed suffocating. Suffocating for 4-6hrs.

Quantity proportion: **Insecticide: water: seed= 1: 50: 500**

- ✓ **Fumigants**: those have been already explained above, see "insecticides for stored seeds"

b. Ways of application

- ✓ **Seed dressing:** Mix the seeds with the pesticide powder or liquid evenly.
- ✓ **Seed soaking:** **S**oak the seeds into the solution for certain time.
- ✓ **Usage**: Prepare the solution. The quantity of usage is usually 500-1000 times solution.
- ✓ **Seed suffocating:** compound the seeds with pesticide and suffocate for several hours.
- ✓ **Usage:** prepare the solution: the quantity of usage is usually (weight):

Chemical: water: seed=1: 50: 500 mix the seed with the solution evenly. Pile with a cover of cloth, plastic film or sacks for several hrs.

c. Method of Seed Dressing

- ✓ Containers with punching holes for rinsing
- ✓ Mixing with shovel for seed dressing
- ✓ Mixing with drum for seed soaking
- ✓ Using cloth, sack or, dusters for seed suffocating.

Self-Check – 4	Written test

Name…………………………………………… ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 (pn'ts) each

1. List the types of seed disinfectants
2. Explain the method of Seed Dressing

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Information sheet 5 - Taking, preparing and forwarding test samples

5.1. Seed characteristics

Seed quality is perhaps the most important aspect of seed production, acquisition and use. A bad seed or seed lot is not only a waste of money, it is a waste of time and it brings mistrust among farmers, seed producers and seed sellers. Bad quality seed affects the entire crop production value chain. Even more important is that bad quality seed with low germination power or count can discourage farmers from purchasing them especially where efforts are being made to introduce improved seed varieties.

- **There are four basic attributes of seed quality to consider**:

1. Physical qualities of the seeds in a specific seed lot
2. Physiological qualities observed as germination and vigour of seeds
3. Genetic quality, which relates to specific genetic characteristics of seed variety
4. Seed health, which refers to the presence of diseases and pests within a Seed lot.

Based on Quality Declared Standards (QDS) of FAO, good quality cereal seeds should have 13-15% moisture content, legumes at 10% or below and vegetable seed at 8% or below.

5.2. Purpose of Seed sampling and testing

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
  - **Seed sampling**

It is the process of obtaining a seed sample of a size suitable for test in which the same constituents are present as in the seed lot and in the same proportions. ... Working sample: The working sample is a sub-sample taken from the submitted sample in the laboratory, on which one of the seed qualities is done.

Figure 5.1 seed sampling

- **Importance of 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 the 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).

- **General Principle of seed sampling**

  - ✓ 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.

  - ✓ 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**
  - ✓ 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.
  - ✓ 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.
- **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.

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

- ✓ Purity,
- ✓ Other seeds by number,
- ✓ Germination,
- ✓ Tetrazolium,
- ✓ Seed health, and
- ✓ Species/variety testing.

- **Purity analysis**

To determine (a) the percentage composition by weight of the sample is tested; and (b) the identity of the various species of seeds and inert particles constituting the sample. 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 sclerotic, 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.

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.

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, sclerotic 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.

- **The Germination test/ Definitions**
  - ✓ 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.

Germination capacity of a seed lot refers to the capacity of the seeds in that lot to germinate normally and produce all parts of a healthy seedling and grows. The necessary parts of the seedling include well developed primary roots, young pair of leaves and one or two cotyledons.

$$\% \text{ of germination} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds germinated}} \times 100$$

A germination rate of 70-80% is an indication of high seed viability. Germination can also be affected by seed dormancy.

- **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.
  - ✓ he 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 Dormancy**

Seed dormancy is the temporary suspension of growth of viable seeds accompanied by reduced internal metabolic activity. It is the resting stage of the seed and it delays germination of the seed. Unfavorable climatic conditions like temperature, variation and lack of water lead to seed dormancy. Dormancy may occur due to the presence of a hard seed coat, immature embryo and also due to the presence of germination inhibitors in the seeds. It may also be due to the exposure of seeds to excess heat, light or darkness and also due to the presence of chemical toxins in the seeds.

Dormancy of the seeds can be broken by any of the following methods:

- ✓ Scarification – Removal of the hard seed coat by rubbing the seeds with sand paper.

Eg. Pulses

- ✓ Hot water treatment – Soak the seeds in hot water at 45-50°C. Eg. Tree crops.
- ✓ Leaching – Soak the seeds in water for overnight to remove the germination inhibiting chemicals present in the seeds. Eg. Coriander
- ✓ Stratification – Subject the seeds to very low temperature of 0-5°C to break the embryo dormancy. Eg. Cole crops.
- ✓ Light treatment – Some seeds do not germinate in dark and periodic exposure to light is essential to break the dormancy. Eg. Lettuce.

Self-Check – 5	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 (pn'ts) each

3. List the types of seed disinfectants

Explain the method of Seed Dressing ***Note:*** **Satisfactory rating – 10 points** **Unsatisfacto**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: ___________________________ Date: ________________

Information sheet- 6 keeping updating and maintaining records

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:

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 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

3. **Quality control and certification records:**

Cost of reagents and materials

Cost of field inspection and certification

4. **Marketing records**

The records can be organized under the following headings: purchase ledger, labor ledger, transport ledger and a ledger for all other costs.

Self-Check – 6	Written test

Name…………………………………………… ID………………………… Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 (pn'ts) each

1. List the types of types of records
2. Explain the data of seed production and should be recorded

***Note:* Satisfactory rating – 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Information sheet 7. Forwarding the records kept to the appropriate person

7.1. Requirements of reporting recorded data

Receive the seeds from the field, including aggregating or bulking.

- ✓ Dry the seeds. Drying is necessary to ensure the right moisture content.
- ✓ Pre-cleaning. During the pre-cleaning process, undesirable elements such as large impurities, sand, thin grains and weeds are to be separated. During this process it is important for the cleaning to eliminate heavy impurities, such as stones, metallic particles and other foreign bodies from the seed products.
- ✓ Fine cleaning. This removes all off-types and ensures phytosanitary conditions are met as much as possible. At this stage the seeds are further examined to pick out mould and seeds that shows diseases on their coats.
- ✓ Sorting and grading into sizes. This ensures that the seeds are not too large or too small, indicating that they have just enough food to sprout.
- ✓ Treatment. At this point seeds could be further dried, aired and in many cases coated with approved agro-chemicals that have an ant-microbial or fungicidal active ingredient. Seed dressing happens at this stage.
- ✓ Packaging. Bagging in the right bag types ensures adequate aeration or complete vacuum.
- ✓ Storage. Seeds are then transported and stored in a pest free shelter on pallets away from the walls to avoid moisture. From the store, seed will proceed to market.

- In general, based on the recorded data about seed processing which explained in information sheet six of **LO 2 which you have to refer it**, the stack holder should have to report, to whom it may concern.

Self-Check – 7	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 (pn'ts) each

1. List the information about processed seed
2. Explain each of them

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

LG #25	LO #3- Store seed

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics: • Selecting the storage facilities to be used and preparing hygienically • Transferring Seed to the storage facility • Storing Seed under conditions that maintain its quality and germination capacity. • Conducting periodical checks of seed in long-term storage for quality factors and viability • Taking Seed samples for laboratory testing as required. • Taking, preparing and forwarding Test samples for analysis • Creating, maintaining and keeping clear and accurate records of seed storage, tests and inspections • Monitoring the condition of storage facilities • Taking appropriate corrective action where it is required • Undertaking activities around the seed storage facilities This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, **upon completion of this learning guide, you will be able to**: • Select the storage facilities to be used and preparing hygienically • Storing Seed under conditions that maintain its quality and germination capacity. • Conduct periodical checks of seed in long-term storage for quality factors and viability • Take, preparing and forwarding Test samples for analysis • Create, maintain and keeping clear and accurate records of seed storage, tests and inspections • Take appropriate corrective action where it is required
Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to "Operation sheets".

Information Sheet 1- Selecting the storage facilities to be used and preparing hygienically

1.1. Selecting the storage facilities

Grain seed storage involves more than just placing grain in a suitably sized receptacle until it is needed. The grain is a major asset in which the grower has invested preparation, sowing and harvesting costs. The asset must be protected because while grain is in storage its quality, and thus its value, deteriorates. High temperature and high moisture are the most significant factors affecting grain quality in storage. Each can cause rapid decline in germination, malting quality, baking quality, colour, oil composition, and many other quality characteristics.

Insects and moulds impair the quality of grain directly by their feeding and development, and indirectly through generation of heat and moisture. High temperatures and moistures favour development of insects and moulds. Development of insects is limited by temperatures below 15°C, and by moistures below 9% in cereal grains. Development of moulds is limited by temperatures below 10°C, and by moistures below 13% in cereal grains. Spraying with insecticides or fumigating minimises insect problems but leaves chemical residues in grain, which break down with time. Presence of residues, and their concentration, affects acceptability of the grain to markets. Some markets prefer grain without residues.

Grain seed buyers will not knowingly accept grain treated at rates higher than those specified on the label, or within the specified withholding period. Good hygiene combined with automatically controlled aeration is sufficient for some growers to maintain grain quality without using any residual treatment. Fumigation with phosphine leaves minimal residues, provided tablet formulations are not mixed with the grain. Check with buyers before spraying grain with insecticides. Insects can still grow and reproduce in very dry grain. Grain dried to a 12 or 13% moisture level will not mold, but can still be very good food for insects. The moisture level in grain has to be 9% or less to slow down insect development. Very high and very low temperatures also slow down insect growth. But most farmers will have trouble getting their grain below 12% moisture and in using temperature to control insect development. They often do not have the special equipment necessary to do these things. More and more farmers do use insecticides to control insects in grain. But some insecticides are dangerous; some are expensive; sometimes they are not available; and there is increasing concern about using chemicals of any kind on food products.

In general, stored products pests thrive in warm, humid environments. Grain with high moisture stored in warm conditions is usually most susceptible to insect infestations. Stored grain pests are important since they contaminate food, lower its nutritive value and create conditions favorable for mold growth.

1.1.1. Maintaining hygiene in storage areas

Whichever kind of storage method a farmer uses, there are certain principles upon which every method is based. Every storage container, no matter what it looks like or what it is made of, should:

- ✓ Keep grain seed cool and dry.
- ✓ Protect grain seed from insects.
- ✓ Protect grain seed from rodents.

All storage methods try to do the above three things. But to do these things requires the following good storage practices:

1. Drying grain well (to 12-13% moisture content) before putting it into storage.
2. Putting clean grain only into containers which have had all old grain, dust, straw, and insects removed.
3. Keeping the grain cool and protected from large changes in outside temperatures. This can be done in a number of ways by using building materials which do not easily pass on changes in outside temperatures to the stored grain, by keeping or building storage containers away from direct sunlight, by painting the containers white.
4. Protecting the grain from insects by following rules for cleanliness and drying, by applying insecticide and/or by putting the grain into airtight storage.
5. Water proofing the buildings and containers as much as possible. This is done both by the way the building is constructed and by applying materials which keep water from soaking into the building material. Storage buildings should be built on well-drained locations. They should not be placed where they will be flooded by ground water run-off during heavy rains.
6. Making sure containers are rodent-proofed in all possible ways.

7. Checking the grain regularly while it is in storage to make sure it is not infested, and following re cleaning instructions to destroy insects, if they are found when the grain is checked.

A farmer who has these seven points firmly in mind will know why a particular silo or storage method has been built or changed in a certain way. And he can then do much to improve his own storage facility by applying the knowledge to his own problems. The ideas and suggestions for storage methods which follow in this section, no matter how different they look, all require that these seven steps be taken if they are to be successful.

1.1.2. Testing storage condition and facilities

The requirements for a good storage system include:

- ✓ Prevention of moisture re-entering the grain after drying
- ✓ Protection from insects, rodents and birds
- ✓ Ease of loading and unloading.
- ✓ Efficient use of space

The longer the grain needs to be stored, the lower the required moisture content will need to be. Grain and seed stored at moisture contents above 14% may experience the growth of molds, rapid loss of viability and a reduction in eating quality. The following table shows the 'safe' moisture content required for different storage periods. A rule of thumb for seed is that the life of the seed will be halved for every 1% increase in moisture content or a 5^oC increase in storage temperature.

Storage period	Required moisture content for safe storage	Potential problems
2 to 3 weeks	14 – 18 %	Molds, discoloration, respiration loss
8 to 12 months	12- 13 %	Insect damage
More than 1 year	9 % or less	Loss of viability

Table 1.1. Condition required to seed storage

Self-Check – 1	Written test

Name…………………………………………… ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer five point for each

1. List the requirements for a good storage system
2. Explain the good storage facility

Note: Satisfactory rating – 10 points Unsatisfactory - below 10 points

You can ask you teacher for the copy of the correct answers.

Information Sheet 2- Transferring Seed to the storage facility

2.1. Requirements of storing seeds

Seed storage refers act of keeping the seeds safe during the storage time until the seeds are sown or marketed. If the seed has extreme cold or extreme hot or extreme moisture, there might be problem of attacking by disease, pest and fungal in seed. Therefore, concerning all these aspect, seed storage should be constructed. The storage also should be constructed to fully protect the seeds from pests and rodents. The optimum conditions for storing seeds that would endure long term storage are:

a. Drying the seed to 5 -7 per cent moisture content.

b. Sealed storage in the absence of oxygen.

c. A storage temperature of 7.5° to 15°C.

Most seeds stores well in cool dry condition. However, some seed may lose viability rapidly when dry. Within limits, for most species, for each 10 per cent decrease in seed moisture the life of the seed is doubled. Likewise the life of the seeds doubles for each 10°C drop in temperatures. Most seeds can be stored at – 18°C for considerable length of time. Seeds of some plants including citrus and chestnut should be stored moist under refrigerated condition. Moist chilling condition is necessary.

1.1.1. Identifying good quality certified seeds

Merely looking at a seed stock cannot assure a farmer of the quality of a seed as we have said in the previous section.

However, good quality seeds which have been certified by the authority will be companied by a label with:

- ✓ Name of seeds (written in bold letters)
- ✓ Variety of the seeds
- ✓ Year of production
- ✓ Expiring dates of seeds (most times printed)
- ✓ Phytosanitary certificate, including the certification and batch number, usually printed in bold on the labels and germination percentage clearly indicated.

Self-Check – 2	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions (5 pn'ts)

a) List the optimum conditions for storing seeds that would endure long term storage
b) Good quality seeds which have been certified by the authority will be companied by a label:

You can ask you teacher for the copy of the correct answers.

Note: Satisfactory rating - 10 points Unsatisfactory - below 10 points

Information sheet 3– Storing Seed under conditions that maintain its quality and germination capacity.

3.1. Seeds packaging and storage conditions

Packaging is necessary to facilitate handling and storage of seeds, comply with any legal requirement, preserve viability and seed quality, make presentable product for selling and maintain variety and lot identity. There are three critical factors that affect grains in storage whether they are kept as seeds or are for consumption. These are temperature, moisture content and relative humidity. All three factors affect the quality of seeds in storage because they may produce the right conditions for pests and diseases to grow.

Temperature: Storage insects and mould thrive within an optimal temperature range between 25-34 °C for most storage insects, and between 15-30 °C for the development of mould. Above or below this range, the development of these threats to the stored products is limited and the losses are negligible. Please note that while high temperatures could be fine for seeds for consumption, seeds for planting will be physiologically damaged when exposed to a very high temperature.

Figure 2.1. Seed storage facility and storing seed

Moisture content is described as the quantity of water bound in the grain kernels, expressed as a percentage by weight of the grain or seed sample. The moisture content of dry grain ranges from 6-15% depending on the type of grain. Moisture content is a determining factor in the proliferation of mould and storage pests.

Relative humidity is the percentage of water vapour in the air between the grains, and represents the equilibrium between the humidity of the air and the moisture content of the grain. If the relative humidity exceeds 65%, mould and storage insects can develop, and stored grains and seeds are susceptible to deterioration. The lower the temperature, relative humidity and moisture content are, the lower the risk of grain damage and reduction of the germination capacity. It is best to harvest fully matured crops and dry them well before storage.

Additionally, seeds can be stored in improved storage bins (silos) made out of galvanized metal sheets. Silos come in different sizes and scales. Some are highly mechanized and monitored scientifically to ensure the balance between moisture, relative humidity and temperature. Small metal silo bins including recycled oil drums) which can hold 100-3,000 kg of grains or pulses, are developing as an efficient and low-cost storage system suitable for small-scale farmers. These silos are loaded from the top, and once they are closed they are inaccessible to rodents or insects. They can also be properly sealed against water leaks. They are normally covered, raised from the ground and placed in a well-ventilated place to control both temperature and humidity.

Figure 3.1. Hermetically sealed bags.

Self-Check – 3	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 10 pn'ts

a) List the elements of climatic condition and explain how they can affect the quality of seed

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10points Unsatisfactory - below 10 points**

Information sheet – 4- Conducting periodical checks of seed in long-term storage for quality factors and viability

4.1. Storage Hygiene

Good hygiene in the grain seed store or storage depot is important in maintaining grain and seed quality. Guidelines for hygiene in the grain store include:

- Keep storage areas clean. This means sweeping the floor, removing cobwebs and dust, and collecting and removing any grain spills.
- Clean storage rooms after they are emptied and this may include spraying walls, crevices and wooden pallets with an insecticide before using them again
- Placing rat-traps and barriers in drying and storage areas. Cats deter and help control rats and mice
- Inspect storage room regularly to keep it vermin proof.

Check the condition of stored grain about every two weeks while grain is cooling , then about monthly after grain has cooled .a check should include ; measurement of moisture content and temperature at several locations .moisture measurement accuracy is dependent on the grain temperature ,so it is best to collect a grain sample , let it warm to room temperature in a plastic bag or other sealed container ,then check the moisture content .also be sure to cover fans and ducts after the grain has been cooled for winter storage to prevalent snow from blowing into the bins.

If grain moisture content is too high, even the best aeration equipment and monitoring management will not keep the grain from spoiling - it only delays the inevitable. For more information the recommended moisture contents of grain seed from, **Table 1.1.of one information sheet**. These recommendations assume the grain is high quality and aerated to control temperatures and moisture migration. Reduce the recommended moisture contents by 1 percentage point when storing low quality grain. This includes immature grain, severely cracked and damaged grain, and grain subject to previous insect or mold activity. Also reduce the recommended moisture contents by at least 1 percentage point for grain in temporary or emergency storage. Going into storage at the proper moisture content does not guarantee grain will remain at that moisture. Grain may be rewet as a result of bin roof or sidewall leaks.

4.2. Identifying the need for repairing and maintain grain storage facilities

- **Cleaning and repairing your storage place:--**
  - ✓ Your storage room or building must be clean. Insects live and have families in dirty places. Rats, mice, and other pests like dirty places too.
  - ✓ Take away and burn or compost all dust, old pieces of grain, dirt, straw, and chaff from the storage place.
  - ✓ There should be no cracks and holes in the floor, ceiling, or walls. Insects and rodents use these holes to get in.
  - ✓ Fill and seal all cracks and holes.
  - ✓ Seal large holes in wooden storage places with sheet metal, flattened tin cans, or pieces of wood.
  - ✓ Concrete and plaster make good sealing material for plaster, brick, and concrete buildings.
  - ✓ Put paint or whitewash on the walls and floors of the storage area. This paint helps close up very small holes. Insects like these small holes.
  - ✓ Do not use any poison until you talk to your extension worker.
  - ✓ Put mesh wire over large openings and windows. This will keep out rats, chickens, and birds.
  - ✓ The roof must keep rain from coming in. The grain must be kept dry.
  - ✓ Mend all holes and openings in the roof.
  - ✓ Clean the outside area around the storage place.
  - ✓ Clean out the containers that you put the grain in.
  - ✓ Bags or sacks for storing grain must be shaken.
  - ✓ Bags or sacks should be boiled in hot water and dried in the sun. Mend any holes you find in the bags.
  - ✓ Check with an extension worker for information on poisons to kill insects and rodents.
  - ✓ The extension worker will know what poison to use. He will know how to use the poison.
  - ✓ Always remember that many poisons can kill animals and people.
  - ✓ Use insecticide on the inside and outside of your storage area.
  - ✓ Put insecticide on all cracks and small places where insects like to live.

- ✓ Put out traps for rodents.
- ✓ A good storage place is free of insects and rodents. It is clean and dry.

Self-Check – 4	Written test

Name………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. Explain the different activities of cleaning and repairing your storage place (8pnts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 8 points Unsatisfactory - below 8 points**

Information sheet 5- Taking Seed samples for laboratory testing

5.1. Important Terminologies In seed sampling

Seed lot: is a specified quantity of homogenous seed.

Seed sampling: is a method by which a representative sample is taken from a seed lot to be sent to a laboratory for analysis.

Seed sample: is a very small quantity of seed, which represents the overall quality of the lot.

Primary sample: a number of single samples drawn from different bags or from different locations of the seed lot in containers or stored in bulk.

Composite sample: a mixture of all primary samples from a seed lot.

Submitted sample: part of the composite sample reduced as necessary and submitted to a testing Station.

Working sample: a reduced sample taken from the submitted sample in the laboratory given for a given quality test.

5.1.1. Sampling requirements

- The seed for sampling should fulfill the following requirements:
  - ✓ The lot to be sampled should not have volume larger than specified subject to a 5% tolerance.
  - ✓ The bags or containers should be easily accessible for the sampler.
  - ✓ The lot should be in properly sealed or sealable bags or containers and loose seeds should not be sampled.
  - ✓ All containers must bear a lot identification number.
  - ✓ The sealed lot should be uniform or homologous.

5.1.2. Sampling equipments and methods

I. Bin or bag samplers

- **Automatic samplers.** They are attached to a stationary processing plant and are not flexible which are used to take samples from the whole cross section of the seed stream while cleaning and packing. Triers are most common and efficient sampling instruments especially for sampling seed in bags or small containers.

The common triers are:

- ✓ **Hand triers**: They are smaller in size used to take samples from different positions of bags and sacks.
- ✓ **Stick triers**: stick or sleeve trier consists of two metal tubes with slots in which one is fitted inside the other. The outer fixed part has a pointed end were as the inner tube is fitted with handle, which can be used to rotate it for closing and opening the slots.
- ✓ **Noble trier**. (Dynamic spear): it is a modified trier used for greater accuracy. It consists of one tube with a pointed end and at the end a hole through which the seeds will enter. The tube should be long enough to reach the centre of the bag to be sampled.

- **Hand samplers**:

  They are used only for chaffy noon-free flowering species which are not suitable to insert triers

II. Laboratory samplers

The working sample from the submitted should be taken by repeatedly dividing on fiat surface4 into smaller portion.

D. Sample size

The quantity of sample to be sent to the seed-testing laboratory should be large enough to represent any variability that exists within the seed lot. The sample weight to seed lot ratio for most cereals and legumes is 1:10000 or 20 00. For moisture content determination, approximately 100g for species that has to be ground and 50g for others should be submitted.

5.2. Grain Sampling and Testing for Quality Maintenance

- ✓ **Grain Sampling**

Formal seed analysis begins with the sampling of the seed lot .To obtain a random sample for testing it is always best to take samples from different parts of the bag or container. If the grain to be tested is from a seed lot contained in more than one bag, sample must be taken from several bags. The rule of thumb for determining how many bags to sample is to take samples from a number of bags that represents the square root of the lot size. For example, if the lot contains nine bags, then sample at least three bags. If the lot contains 100 bags, then sample from at least 10 bags.

The Rules for Testing Seeds (AOSA 1996) and the International Seed Testing Rules (ISTA 1996) both give instructions on how to draw samples from a seed lot so that the sample is representative of the entire seed lot.

Sampling can be done with the *hand* or with a *seed probe*, also known as a *Trier.* If a probe is used, it must be long enough to reach to the farthest edge of the container to take the primary sample. The International Seed Testing Association (ISTA) provides guidelines for the intensity of sampling, that is to say the number of primary samples that must be drawn from the seed lot in order to establish the submitted sample. The sampling method depends on the size of the containers of the seed lot: Seed lots in containers between 15 to 100 kg: the minimum number of primary samples depends on the number of containers:

Table 5.1.seed lot and the size of primary sample

Number of containers	**Number of primary samples to be drawn**
1-4	3 from each container
5-8	2 from each container
9-15	1 from each container
16-30	15 primary sample in total of the seed lot
31-59 containers	20 primary sample in total of the seed lot
60 or more containers	30 primary sample in total of the seed lot

Seed lots in containers smaller than 15 kg shall be combined into sampling units not exceeding 100 kg and the sampling units shall be regarded as containers in the above sampling scheme. Seed lots in containers greater than 100 kg: the minimum number of primary sample depends on the size of the seed lot:

Table 5.2. Lot size Number of primary samples to be drawn

up to 500 kg	At least five primary samples
500-3,000 kg	One primary sample for each 300 kg but not less than 5
3,001-20,000 kg	One primary sample for each 500 kg, but not less than 10
20,001 kg and above	One primary sample for each 700 kg, but not less than 40

For seed lots in container smaller than 15 kg, containers must be combined (theoretically) to sampling units not exceeding 100 kg, and the sampling units regarded as containers in the sampling scheme for containers between 15 and 100 kg. The following formula allows the calculation of the number of sampling units in a seed lot:

Number of sampling units = (number of containers x size of a container) /100

For example: if a seed lot is made of 10,000 bags of 0.5 kg of seeds. 50 sampling units of 100 kg can be combined out of these 10,000 bags.

According to the sampling method used for containers between 15 to 100 kg, 20 primary samples must be take in total of the seed lot. All of the primary samples are then placed together to make up the composite sample. Sampling by hand is sometimes necessary when the seeds will not flow into the probe because of their size, shape, or surface texture. Sampling by hand can be done by inserting the open hand into the seeds, closing it once the point of sampling is reached, and then withdrawing it closed. At least 5 handfuls must be taken, and all levels must be sampled. When the hand cannot be inserted into the seed lot, the seeds can be poured from one container into a second, stopping at a minimum of 5 evenly spaced intervals and removing a handful of the seeds for the composite sample.

The *composite sample*, whether taken with a probe or by hand, is usually too large to submit to a seed laboratory for analysis. The composite sample is, therefore, mixed (mechanically or by hand with rulers) and divided to obtain a submitted sample. This procedure is very important and must be done correctly for the results to be accurate. Hand mixing, the composite sample is done by pouring the seeds into a cone on a flat, clean surface.

The size of the *submitted sample* for some species is stated in the Rules for Testing Seeds (AOSA 1996) and is twice as large as the minimum amount for the purity test. This amount is different for each species and the rules need to be consulted to be sure the correct amount is submitted for purity tests that are to be done according to the rules. A smaller sample of seeds can be submitted, but the test will not be according to the rules and the accuracy cannot be assured to the same degree as a test that is done according to the rules. If a species is not listed in the rules, an amount that contains 2,500 seeds should be taken. This amount can be estimated by counting out 100 seeds and multiplying their weight by 25.

Under the AOSA rules, samples can be as small as 600 seeds when only germination is tested. It is important to work quickly when drawing the sample, if the submitted sample is to be tested for moisture content. This will prevent the gain or loss of moisture from the air. Once obtained, the submitted sample should be put in a moisture-proof container to maintain its true moisture content until it is sampled and tested at the laboratory. Plastic bottles with tight-fitting lids or tightly closed plastic bags of at least 0.1 mm thickness are adequate. Metal containers can be used but are harder to find. Glass containers should not be used; they easily break in transport, allowing the samples to be exposed to the air or, worse, mixed together.

Working sample: - it is a subdivision of the submitted sample.

Self-Check – 5	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. Define the following terminologies (2 pn’ts for each)
   a. Seed lot
   b. Seed sampling
   c. Seed sample
   d. Primary sample
   e. Composite sample
   f. Submitted sample
   g. Working sample

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 14 points** **Unsatisfactory - below 14 points**

Information sheet 6- Taking, preparing and forwarding Test samples for analysis

6.1. Preparing test sample for analysis

- **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 the 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).
- **Objectives of grain seed testing:**
  - ✓ To determine the grain quality i.e., their sustainability for planting.
  - ✓ To identify grain quality problems and their probable causes.
  - ✓ To determine if grain meets established quality standards or labeling specifications.
  - ✓ To establish quality and provide a basis for price and consumer discrimination among lots in the market.
  - ✓ To determine the need for drying and processing and specific procedures that should be used
- **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.

6.2. Sample analysis

I. Seed purity test

The goal is to determine the composition by weight (in %-age) of the seed lot being tested. It also helps to estimate the amount for seed to be sown per unit area. Possible components of seed loot,

- Pure seed
- Foreign seeds (weed seeds, and other crop species)
- Inert matter (chaff, empty seeds, debris, etc.)

The sample from a seed lot can be taken on the basis of number count or weight, depending on the crop species under consideration. Before sampling a seed lot, it is important to see that the lot is uniform. Then a sub-sample is prepared which is known to contain about 25 000 seeds in number with a maximum of 1000g. This can be estimated based on the 100 or 1000 seed weight of the crop. The estimated weight of 25 000 seeds in number of some crops is given in the following table.

Table 6.1. Sample weights for number count tests

Crop	Weight to be tested
Pearl millet	150
Rice	400
Lentil	600
Sorghum	900
Wheat, barley, oats	1000
Chickpea, grams	1000

The number count test is particularly relevant in crops that are machine harvested since significant amount of damaged seeds admixtures are expected. This method is applied to most field crops and is less useful for crops, which are not expected to contain other seeds: e.g. most hand-picked fleshy fruits and vegetable crops such as tomatoes, egg plant or cucumber as well as large-sized seeds like beans and maize usually.

II. Germination test

Germination is the emergence and development from the seed embryo of those essential structures which, for the kind of seed in question. It also indicates the seeds applied to produce normal plants under favorable conditions in the soil. The main goal of germination test is to determine the intrinsic (real) seed germination capacity of a lot and percentage of normal seedlings, which can be produced by the lot under more or less ideal condition. Samples are often grown in laboratory determine percentages of.

$$\% \text{ Germination} = \frac{\text{number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

Self-Check –6	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pn'ts for each

1. List the objectives of grain testing**:**
2. Explain Possible components of seed loot

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 10 points Unsatisfactory - below 10 points**

Information sheet 7- Creating, maintaining and keeping clear and accurate records of seed storage, tests and inspections

7.1. Recording grain test and inspection

Regular inspections should be carried out to determine the condition of the building, particularly its electrical installations, locks, roof, and structural integrity in general. Any necessary repairs must be carried out as soon as possible to prevent the damage from getting worse. Failing to monitor grain conditions throughout the entire storage period is a mistake that many producers make. Regular inspections are essential if mold and insect activities are to be detected early. A small area that starts to heat or otherwise go out of condition can quickly get out of control and spread within the bin.

How often you need to check the grain in storage will vary with the time of year, the initial condition of the grain and how often the grain is aerated. Generally, grain should be inspected at least once a month during the winter and every two weeks during the spring, summer and fall. Grain checking is extremely important during the summer, because grain is being held at higher temperatures and aeration conditions are less favorable than during the rest of the year.

Grain temperatures should be checked and recorded during each inspection. Without temperature records, it is difficult to tell whether evaluated grain temperatures are caused by normally occurring outside temperatures or by heating due to mold activity. Use a deep bin probe to obtain samples at different locations in the bin to determine the moisture content, the amount of trash and fines and the general condition of the grain. An accurate moisture tester is required to determine actual moisture contents. You can check the accuracy of your tester by checking readings with your local elevator.

When checking your bins, look for:

- ✓ Condensation on the grain surface, crusting, wet areas, molds and insects.
- ✓ Leaks or condensation on the bin roof.
- ✓ Non-uniform temperatures in the grain mass, pockets or layers of high-moisture grain, molds and insects.
- ✓ Musty or sour odors, spoiled grain gives off a detectable odor, but in most cases, the spoiling grain must be near the surface of the grain and the grain must have under gone considerable

spoilage before you can detect any odor. Generally, if you can smell a musty odor, a problem is already under way. Any problems that are found n to be evaluated and corrected as soon as possible. This may include cooling with aeration, further drying or fumigation for insect control.

- **Maintaining storage hygiene and technical measures includes:**

✓ Keep the store absolutely clean! Remove any spilt grain immediately as it attracts rodents!

✓ Store bags in tidy stacks set up on pallets, ensuring that there is a space of Im all round the stack!

✓ Store any empty or old bags and fumigation sheets on pallets, and if possible in separate stores!

✓ Keep the store free of rubbish in order not to provide the animals with any places to hide or nest! Bum or bury it!

✓ Keeps the area surrounding the store free of tall weeds so as not to give the animals any cover! They have an aversion to crossing open spaces.

✓ Keep the area in the vicinity of the store free of any stagnant water and ensure that rainwater is drained away, as it can be used as source of drinking water.

- **Inspect grain frequently during storage**

Stored grain should be inspected frequently. Insect or mould activity gives a distinct odour to air moved through the grain. By operating the aeration system and smelling the air coming through the grain, storage problems can be detected. Any 'hot spots' should be cooled as soon as possible by aeration. If the problem is due to insect activity, the grain should be fumigated.

Self-Check –7	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pn'ts for each

1. Explain Maintaining storage Hygiene and Technical Measures

You can ask you teacher for the copy of the correct answers.

***Note:* Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

Information sheet 8- Monitoring the condition of storage facilities

8.1. Conditions of storage facilities

As an employer of workers facing these hazards, you have the legal obligation to protect and train your workers. OSHA will not tolerate non-compliance with the Grain Handling Facilities standard. OSHA has investigated several cases involving worker entry into grain storage bins where we have found that the employer was aware of the hazards and of OSHA's standards, but failed to train or protect the workers entering the bin. OSHA has aggressively pursued these cases and we will continue to use our enforcement authority to the fullest extent possible. Just in the last 10 months, OSHA has issued three large penalty citations to grain elevator operators for these very hazards.

- **When workers enter storage bins, employers must take the following care:**

✓ Turn off and lock out all powered equipment associated with the bin, including augers used to help move the grain, so that the grain is not being emptied or moving out or into the bin. Standing on moving grain is deadly; the grain acts like 'quicksand' and can bury a worker in seconds. Moving grain out of a bin while a worker is in the bin creates a suction that can pull the workers into the grain in seconds.

✓ Prohibit walking down grain and similar practices where an employee walks on grain to make it flow.

✓ Provide all employees a body harness with a lifeline, or a boatswain's chair, and ensure that it is secured prior to the employee entering the bin.

✓ Provide an observer stationed outside the bin or silo being entered by an employee. Ensure the observer is equipped to provide assistance and that their only task is to continuously track the employee in the bin

✓ Prohibit workers from entry into bins or silos underneath a bridging condition, or where a build-up of grain products on the sides could fall and bury them.

✓ Test the air within a bin or silo prior to entry for the presence of combustible and toxic gases, and to determine if there is sufficient oxygen.

✓ Ensure a permit is issued for each instance a worker enters a bin or silo, certifying that the precautions listed above have been implemented.

. **8.2. Maintaining grain seed storage facility**

Maintaining the quality of grain seed in storage requires an integrated approach that incorporates a number of tools and practices. Storing only clean grain at the proper moisture content and temperature, sanitizing the bin before loading, checking the grain condition regularly and correcting problems before they get out of hand are critical management strategies that must be implemented to prevent grain deterioration and possible economic loss.

It is critical to carefully manage stored grain to prevent grain deterioration and possible serious economic loss.

This management should include:

- ✓ A well-designed and properly-operated storage system with adequate aeration capacity.
- ✓ Storing only clean grain at the proper moisture content and temperature.

- **Monitoring grain seed storage facility**
  - ✓ Clear and strict procedures must be in place to control the arrival and delivery of the supplies.
  - ✓ Each new arrival must be recorded in the inventory. Even those products that arrive in poor or unusable condition must be recorded as such.
  - ✓ A stock control card must be available for every type of product stored in the warehouse.

On the card, the dates and quantities that have arrived must be recorded; spaces must also be available on the card to register information about the delivery of the supplies. The current level of stocks of the same product must be recorded, as well as the sector of the warehouse where the product is kept.

Regular inventories should be performed; control cards, printed inventories, and the computer database (if one is in place) should be kept up to date. Inventories and delivery documents should correspond to the information recorded on the stock control cards. Clear and up-to-date controls and records of losses and certification of expired or spoiled items must be kept. Normally, the destruction or discarding of expired or spoiled medicines must be carried out under the supervision of a specialist. Individual forms are needed to record all warehouse activities, such as arrivals, deliveries, and requisitions. These forms should be numbered consecutively and must include the date and basic information about the people involved in the process.

- **In generally, Crop protection measures during storage includes:-**
  - ✓ Construction of adequate storage facilities
  - ✓ Optimization of drying procedures
  - ✓ Spraying the store with appropriate chemicals
  - ✓ Regular turning of sacks (heaps)
  - ✓ Fumigation
  - ✓ Rodent control

Self-Check –8	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pn'ts for each

1. Explain the conditions of storage facilities
2. Crop protection measures during storage

You can ask you teacher for the copy of the correct answers.

***Note:* Satisfactory rating – 10 points Unsatisfactory - below 10 points**

Information sheet 9- Taking appropriate corrective action

9.1. Taking corrective action to maintain grain quality

Corrective action include maintenance activities such as inspection for structural problems ,repair of physical damage ,sealing of inlets and outlets to maintains gas tightness ,pressure testing of sealed storage to recommended levels ,location and repair of leak in sealed storage , maintenance of pressure relief valves and painting and up keep of heat reflecting coating . Corrective action might also include the operation of installed equipment where it exists. for example refrigeration may be used on storage facilities holding malt quality barely or sorghum or where high moisture content is jeopardize grain quality . matching the cooling load with equipment selection may involves site specific data and calculation , combined with the use of manufacturer data . Additionally, aeration might asset tom reduces grain temperature and grain moisture levels to client and organization requirements.

Good quality, clean, sound grain is much easier to maintain in storage than cracked and broken grain. Broken kernels will mold three to four times faster than whole kernels. Broken grain also is more susceptible to insect attack, since some insects feed only on broken or cracked kernels. It is critical that initial grain condition receives considerable attention. In addition to careful combine adjustment and operation, moisture content is a key factor influencing grain damage during harvest. The least grain damage generally occurs at moisture contents of 18 to 20 percent. The amount of damage increases slightly for moisture contents below this range, but increases rapidly for moisture contents above this range. Also, frozen grain damages easily, and combining or handling should be avoided if possible.

To help assure that only high quality grain goes into storage, the following is recommended:

- Clean around the bin site and remove any old grain, grass, weeds, and other debris.
- Remove all traces of old grain from the bin and harvesting and handling equipment.
- Properly adjust the combine to minimize grain damage.
- Clean the grain as it is put into the bin, preferably using a rotating grain cleaner.
- Cool the grain to the prevailing outside air temperature as soon as it is put into the bin.

Self-Check –9	Written test

Name…………………………………………… ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pn'ts for each

1. List and explain Taking corrective action to maintain grain quality

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

Information sheet 10- Undertaking activities around the seed storage facilities

10.1. Maintain hygiene in storage areas

Losses in storage can be minimized or prevented by maintain hygiene in storage areas. This can be adopting any or combination of the following techniques:-

- **Sanitation**

Before adding grain to a storage facility, make sure it is clean and free of old grain, trash, and insects. Be sure the walls, ceiling, sills, ledges, floors, loading/unloading equipment, and the ventilation system (under perforated floors, ducts, and fan system) are clean. The area outside the bin should also be free of insects, weeds, and grain products. Insects can breed and persist in these areas and infest new grain when it is placed in the bin. It is best to clean and treat storage facilities at least two weeks prior to adding new grain.

Most stored-grain insect infestations originate in the immediate area of the storage facility; therefore, area sanitation is important. Many of the common stored-grain pests have the ability to move from one facility to another. Practices that limit the pests' access to food and shelter will help reduce the potential for future infestations.

- **Treatments storage facilities**

The ideal grain treatment should be:

- ✓ very effective against seed-borne pathogens,
- ✓ relatively nontoxic to animals and plants, even if misused,
- ✓ effective for a long time during seed storage,
- ✓ Easy to use, acceptable, and Economical.

Disinfestations require a systematic and thorough cleaning of all sources of infestation before storage. Old grain residues in the storehouses, grain bins, harvesting and threshing equipment should be treated, removed or destroyed. Storage containers, structures and equipment can be treated with:

- Malathion (50EC) at 5ml/20l of water @20ml/m^2
- Fenitrothion (50EC) at 5ml/l water @20ml/m^2
- Deltamethrin (2.5% WP) at 1.5g/l water @20ml/m^2

If thorough cleaning of containers is not possible, the containers may need to be sealed and fumigated with phosphine. All second hand bags should be examined and where necessary treated with either a fumigant, insecticide or dipped in boiling water. Solutions of Malathion (50 %EC) and Fenitrothion (50EC) at 5ml/20 l of water and Deltamethrin (2.5% WP) at 1.5g/l water @20ml/m2 can be used for dipping the bags

10.2. Effective Grain Storage area managements

Grain going into on-farm storage should have a maximum of 12 percent moisture. This means that growers storing grain on farm will need to measure moisture levels as grain is put into storage and then monitor stored grain moisture, temperature and insect activity regularly. Grain stored at too high a moisture level can be affected by mould and fungal growth and will be at a higher risk of insect attack. It's important not to expect aeration to dry grain to any great degree of typical aeration on-farm is for cooling, aeration drying is a whole different practice. If growers are considering aeration to dry grain then it is important they seek correct advice and use equipment which can do the job.

Grain quality can steadily deteriorate if the storage environment is not managed correctly. Generally, the combination of good farm hygiene plus well-managed aeration cooling can overcome storage pest problems. When managing stored grain, prevention is better than cure and a number of basic steps can be taken to minimize problems that can result in reduced grain quality. Including:

- ✓ Maintaining good farm hygiene. Clean up grain residues in empty storage facilities and all grain handling and carriage equipment before new grain is stored and equipment used. Clean up spillages in areas around silos and destroy all residues to prevent re-infestation.
- ✓ Ensuring insect pests or weeds are not carried onto properties on farm equipment such as harvesters. All equipment should be thoroughly cleaned down after use. The first grain through
- ✓ Once storages and equipment have been cleaned, treat them with a diatomaceous earth treatment.
- ✓ Check the seals on gas-tight sealed silos before each filling and replace them if they are worn or damaged. Carry out a pressure test to be sure the silo is gas-tight before fumigating.

- ✓ Install aeration cooling fans in storages to cool grain, and for best results install an aeration controller. Freshly harvested grain usually has a temperature around 30°C which is an ideal breeding temperature for many storage pests. Aeration fitted to stores can rapidly reduce grain temperature which reduces insect breeding and assists in maintaining grain quality.
- ✓ Monitor grain monthly for insects, moulds, grain temperature and moisture.

Generally, grain stored for more than six weeks should be treated for insect pests and fumigation must be done in pressure-tested sealable gas-tight silos.

Self-Check –10	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pn'ts for each

1. Explain the maintain hygiene in storage areas
2. Define the Sanitation

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 10 points Unsatisfactory - below 10 points**

Operation sheet 1– Conducting germination tests

1. Procedures of seed germination test

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

- **% germination = $\frac{\text{number of seeds germinated}}{\text{Number of seeds sown}} \times 100$**

Operation sheet 2– Performing seed processing

2. **Seed processing steps**

1. Sorting out good quality material.
2. Shelling/ Threshing.
3. Drying
4. Cleaning.
5. Grading
6. Treatment with insecticide/fungicide.
7. Packaging.
8. labeling
9. Storage.

LAP Test	Performance Test

Name……… …………………………………….. ID…………………….. date…………

Time started: ________________Time finished: _________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1:30** hour for both tasks. The project is expected from each student to do it.

Task-1-show the procedures of germination test

Task -2- show the seed processing steps

LG #26	LO #4- Collect and deliver seed

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Establishing and applying delivery or supply terms
- Selling or purchasing seed conforms
- Observing regulations relating to the interstate movement of seeds

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, **upon completion of this learning guide, you will be able to**:

- Establish and applying delivery or supply terms
- Sell or purchasing seed conforms
- Observe regulations relating to the interstate movement of seeds

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information sheet.1 Establishing and applying delivery or supply terms

1.1. Marketing principles and objectives

Seeds, fertilizers, pesticides, implements, and machinery have to be directly available to the farmer at the proper time in order to serve the requirements of his crops. They must also be of the correct quality and supplied at reasonable cost in relation to the particular needs of the farmer. It is the role of marketing agencies to organize the supply of these inputs and to arrange the related services required. This concept of "marketing" covers all business activities involved in the flow of goods from production to consumption - that is, for seed marketing, from the first multiplication stage of the basic material up to the distribution of the converted end product to farmers engaged in crop production.

In the developed countries, the success of the cereal and legume seed industry has often resulted from integration of agricultural research, production technology, input supply, market support and extension information. The success and rapid expansion in soybean production is attributed to investments in research, effective extension programmes, price support, encouragement to the processing industry, and facilitating export markets. They suggested that similar efforts are needed for legumes in developing countries.

1.2. Basic requirements

Marketing of seed requires special skill.

- ✓ Those who are in charge of operations need a broad knowledge of agriculture and commerce and should be tactful. Implementation of a sound marketing system aiming at the eventual improvement of agricultural production and productivity will depend upon the following conditions:
- ✓ A clear-cut policy for developing the seed industry, defining the tasks and responsibilities of the official, semiofficial, and private economic sectors of the particular country.
- ✓ Availability of well identified and adapted varieties.
- ✓ Current official information on new varieties that have been recommended and released for crop production.
- ✓ Ensured variety maintenance and basic-seed supply for reproduction.

- ✓ Effective legally enforced control procedures to ensure uniform quality levels according to internationally recognized standards.
- ✓ Comprehensive marketing intelligence to indicate consumer requirements, appropriate production areas, location and size of market demand, and costs.
- ✓ Adequate production, storage, processing, and testing facilities for producing and maintaining seed quantities and qualities m accordance with the established standards.
- ✓ Intermediate storage and transportation facilities for the wholesale and retail sales sectors.

1.3. Demand assessment and promotion

In planning the marketing of seed the producer and seller (often the same entity) are initially faced with the question of the size of the market that is, how many farmers will decide to buy how much seed. To be in a position to supply the farmer on request with the required quantities and types of seed, appraisals of the demand have to be made one or two years in advance of the sales period. Calculation of *potential national demand* (total seed requirement) for government services or central marketing agencies is based on cultivated acreage, seed rates, impact of extension efforts on the introduction of improved production techniques, and future plans for promotion.

Resistance to innovation

Use of improved seed, like that of any new input, has to be fully accepted by the farmer, who tends to be conservative, particularly if a change of techniques involves an expenditure of money as well as of extra effort.

Variety changes

Successful introduction of new varieties and cultivation techniques generally calls for sustained and expensive demonstration and extension work on farms. Breeders are continuously searching for higher yielding varieties with an improved resistance to diseases or pests and of a quality better suited to market requirements.

Financing capacity

Small farmers who are close to subsistence level have hardly any financing possibilities, except perhaps during a short period just after their harvest has been sold. At planting time they are tempted to take seed from the preceding crops so as to avoid having to pay for good-quality seed. If credit is not provided, this practice can be a real obstacle to expanding the areas under improved varieties.

Economic incentives

An economist measures the attractiveness of a production alternative or improvement by the ratio between benefits and costs. Compared with other production inputs, this ratio as calculated for additional yields from improved seed is generally most attractive. It may be stated as follows:

$$\textit{Benefit/cost ratio} = \frac{\text{use of the input}}{\text{Cost of the input to farmer}}$$

Because the total benefit of a "package" of appropriate inputs is normally greater than the sum of the benefits of the component inputs, the availability of additional inputs required should be considered when assessing seed demand.

Self-Check –1	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pn'ts for each

1. Clarify the Marketing principles and objectives
2. The special skill marketing of seed requires

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information Sheet 2- Selling or purchasing seed conforms

2.1. Buying or selling seed

All seed offered for sale in containers or in bulk for sowing purposes in Ethiopia must have attached a seed label containing the information required by the Minnesota Seed Law. Proper labeling is the responsibility of the person or firm whose name appears on the label as the labeler. There are no exceptions to this requirement. A legal seed label in Minnesota includes the following:

Seed labeling protects the farmer by providing truthful information about the source, genetic identity or variety, and quality of the seed being purchased. Expected performance of the seed should be based on varietal characteristics and the quality factors listed on the label. Without a label, there is no declaration of capability and no proof the seed is actually intended for planting purposes. Without proof, it can be difficult, if not impossible; to seek damages from a seed seller if a farmer believes the seed didn't perform as expected.

Seed labeling also protects labelers, distributors, and retailers by providing truthful information about the performance capability of the seed. This means that if the seed is used properly by the buyer, it will provide the desired performance under normal growing conditions. Initial labelers are required to have a current Minnesota seed permit, even if the firm is located out of state. An initial labeler is the first person or firm to label the seed when it is offered for sale in Minnesota. There are no exceptions to this requirement. Minnesota seed permit fees are based on the volume of seed sold in the state.

Points to keep in mind

- **Seed sellers**

✓ Label seed completely and accurately.

✓ Make sure licensing agreements allow you to sell seed of the variety you plan to market.

✓ Know the certification requirements for the variety you are marketing and comply with them.

✓ Keep the required records for each lot sold.

✓ *Obtain a permit if one is needed.*

- **Seed Buyers**

- ✓ Buy seed only from a reputable source.
- ✓ Carefully review seed ads to make sure they
- ✓ Are providing the information you need.
- ✓ Never buy seed that isn't labeled.
- ✓ Be aware of certification and patent restrictions.
- ✓ Keep a copy of the label for each lot purchased
- ✓ As well as all receipts

Self-Check –2	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 10 pn'ts for each

1. List and explain the main point the buyers and seller of seed should have to keep in mind
2. Define the Sanitation

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

Information Sheet 3 - Observing regulations relating to the interstate movement of seeds

3.1. **Marketing structure and functions**

The various channels through which seed can be marketed vary greatly from one country to another, and when more than one marketing organization operates in a country, it depends upon their management which channels are chosen. Seed production may be centered in one area of a country, usually for economic reasons, whereas the market is often more widespread. In any event, a system of distribution from central production plant to customer should be established; this will usually require some middlemen in order to achieve satisfactory distribution. Several outlets can be chosen, and which kind of structure is established often depends upon economic and political circumstances.

Timing of supply

The best time for sowing is normally limited to a few weeks in each growing season. Seed which has not reached the farm by sowing day will not be sold before the next season. To facilitate Timely supply and to assess needs more accurately, traders encourage advance ordering; however, such advance commitments are not natural for farmers, who are already concerned about the uncertainty of their yields and the risks of bad weather or attacks by pests or diseases. Advance ordering may be induced either by strong discipline imposed by a central organization, such as cooperative or government agency, or by pricing incentives, such as seasonal discounts.

Place of delivery

It is often not feasible for retailers to deliver to each farm the small quantities of seed needed for planting one or two hectares perhaps only 100 or 200 kg; however, farmers can carry a few bags of seed home from the market or store by horse cart or on the back of a donkey. Delivery Service for groups of farmers may be arranged for specific dates in market places, villages, or even fixed roadside locations. This arrangement can be organized through a group leader who agrees to take responsibility for the group order.

Packing

The packing of seeds requires careful attention. Unfortunately, this is often ignored in countries where seed is seen as just another agricultural product and the containers used are certainly not serving the purpose. Seed delivery to site is a critical step in seed-based restoration programs. Months or years of seed collection, conditioning, storage, and cultivation can be wasted if seeding operations are not carefully planned, well executed, and draw upon best available knowledge and experience. Although diverse restoration scenarios present different challenges and require different approaches, there are common elements that apply to most ecosystems and regions. A seeding plan sets the timeline and details all operations from site treatments through seed delivery and subsequent monitoring.

The plan draws on site evaluation data (e.g. topography, hydrology, climate, soil types, weed pressure, reference site characteristics), the ecology and biology of the seed mix components (e.g. germination requirements, seed morphology) and seed quality information (e.g. seed purity, viability, and dormancy). Plan elements include:

(1) Site treatments and seedbed preparation to remove undesirable vegetation, including sources in the soil seed bank; change hydrology and soil properties (e.g. stability, water holding capacity, nutrient status); and create favorable conditions for seed germination and establishment.

(2) Seeding requirements to prepare seeds for sowing and determine appropriate seeding dates and rates.

(3) Seed delivery techniques and equipment for precision seed delivery, including placement of seeds in germination-promotive microsites at the optimal season for germination and establishment.

(4) A monitoring program and adaptive management to document initial emergence, seedling establishment, and plant community development and conduct additional sowing or adaptive management interventions, if warranted.

(5) Communication of results to inform future seeding decisions and share knowledge for seed-based ecological restoration.

Self-Check –3	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions 5 pn'ts for each

1. Explain the impacts of timing supply, Place of delivery and packing on seed delivery systems

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 5 points** **Unsatisfactory – below 5 points**

References

Besancon, Thierry Besancon et.al. (2018) Sorghum Growth and Development. USA: Department of Crop Science North Carolina State University.

Difference between Seeds and Grains. 2010. DifferenceBetween.net. Accessed on line February 2019

FAO 2010. Seeds in Emergencies: A technical handbook. Seed and Seed Quality for Emergencies Appendix 14. Reprinted 2011

FAO. 2014. Appropriate Seed and Grain Storage Systems for Small-scale Farmers: Key Practices for DRR Implementers. Italy. FAO Publication.

International Center for Agricultural Research in the Dry Areas (ICARDA) (2006) Farmer participatory seed production of improved varieties of cool season food legumes and durum wheat. In: *Technology Generation and Dissemination for Sustainable Production of Cereals and Cool Season Food Legumes: Progress Report, Third Season 2004–05*. ICARDA, Aleppo, Syria, pp. 138–142.

Srimathi, P., et al., 2008. *Approaches for Commercial Seed Production.* Department of Seed Science and Technology, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. pp. 150.

World Vision South Sudan. 2018. Adaptive Research Protocol Report. Juba South Sudan: World Vision South Sudan. (2018)

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The Trainer Who Developed TTLM

R/No		Qualification	Educational background	Region	Phone Number	Email-address
1	Deribow Gonfa	A	Plant science	Oromia	0912774688	gonfad24@gmail.com
2	Leta Abebe	B	Plant science	>>	0921768274	letaabebe361@gmail.com
3	Gexenesh Balay	A	Plant Science	>>	0911449053	nebzek2@gmail.com
4	Temirat Tirfessa	B	Plant science	>>	0910891318	tirfessatamirat@gmail.co
5	Seboka Adugna	B	Plant science	>>	0910545516	Adugnaseboka@gmail.com
6	Jemal Furo	B	Plant science	>>	0915647611	jemshusni@gmail.com