Seed Business Management in the Context of Smallholder Farmers

Training Manual

Tropical Legumes III (TL III)
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## Abbreviations

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<th>Full Form</th>
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</thead>
<tbody>
<tr>
<td>ARI</td>
<td>Agricultural Research Institute</td>
</tr>
<tr>
<td>ASA</td>
<td>Agricultural Seed Agency</td>
</tr>
<tr>
<td>CGIAR</td>
<td>Consultative Group for International Agricultural Research</td>
</tr>
<tr>
<td>CIAT</td>
<td>International Centre for Tropical Agriculture</td>
</tr>
<tr>
<td>ESAFF</td>
<td>Eastern and Southern Africa Small Scale Farmers’ Forum</td>
</tr>
<tr>
<td>ICRISAT</td>
<td>International Crops Research Institute for the Semi-Arid Tropics</td>
</tr>
<tr>
<td>IITA</td>
<td>International Institute of Tropical Agriculture</td>
</tr>
<tr>
<td>ISTA</td>
<td>International Seed Testing Association</td>
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<tr>
<td>NARS</td>
<td>National Agricultural Research Systems</td>
</tr>
<tr>
<td>NaSARRI</td>
<td>National Semi-Arid Resources Research Institute</td>
</tr>
<tr>
<td>NaCRRRI</td>
<td>National Crop Resources Research Institute</td>
</tr>
<tr>
<td>TOSCI</td>
<td>Tanzania Official Seed Certification Institute</td>
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<tr>
<td>TL III</td>
<td>Tropical Legumes III</td>
</tr>
</tbody>
</table>
1. About this Manual

1.1 How is the manual written?
The manual presents useful information tailored to the needs of intended users, to better manage seed business. Simple and straightforward language is used to facilitate the understanding of the user. Practical content and tools are presented in the manual to help users to improve management and growth of seed business.

1.2 What to expect from this manual?
This is a training of trainers’ manual that discusses various themes on the subject of seed business management, such as:

- Background information specific to smallholder farmers.
- Principles of seed production, management, processing, testing and marketing.
- Models of seed business management for smallholder farmers.
- Developing a seed business plan.

In addition, the manual offers a selection of complementary reading material for further reference.

1.3 Intended users
This manual is written for operational staff who engage in field work and meet with beneficiaries involved in the implementation of seed project activities. Beneficiaries include: national agricultural research systems (NARs), researchers, extension workers, persons in charge of seeds, representatives from: seed companies, farmer organizations, agro-dealers, NGOs, civil society organizations, and regional agriculture authorities.

2. Introduction to the Training Manual

2.1 Context
The Tropical Legumes III is a research and development project targeting major dryland grain legume crops that possess commercial potential to fight hunger, increase income and improve production systems for resource-poor farmers. The TL III project is funded by the Bill & Melinda Gates Foundation and jointly implemented by ICRISAT, International Center for Tropical Agriculture (CIAT), International Institute of Tropical Agriculture (IITA) and National Agricultural Research Systems (NARS) from seven African countries and one Indian state.

The objectives of the TL III project are to: (i) develop improved cultivars of common bean, cowpea, chickpea and groundnut in order to deliver improved seeds to smallholder farmers, (ii) strengthen the breeding programs of NARS and the Consultative Group for International Agricultural Research (CGIAR) and (iii) enhance capacity to utilize integrated legume innovations for research and production purposes and to deliver seeds of new varieties to smallholder farmers.

In Tanzania and Uganda, two of the eight target countries, groundnut improvement and seed systems activities are led by ICRISAT, while CIAT leads the work on common beans. In both countries and for both crops, there is strong involvement from NGOs, public and private sectors.

This involvement ensures effective delivery of innovations that secure harvests, against drought and outburst of major pests and diseases while guaranteeing high yields, quality, and effective marketing systems.

To deliver seeds of groundnut and common bean at scale, there is need to strengthen the capacity of stakeholders in seed business management. In line with the country focal point work plans, this training
is organized to discuss, seed business models that can function in the context of smallholder farmers. The training sessions last four days and gather partners in Tanzania and Uganda. It consists of sharing experiences, discussing the basics of successfully managing a seed business and specific examples that fit smallholder farmers.

2.2 Objectives
This manual seeks to:

- Refresh national partners on the basics of seed business management for legume crops.
- Introduce national partners to a specific model of seed business tailored to smallholder farmers.
- Impart skills to national partners in the development of a seed business plan.
- Develop an implementation plan with partners on the discussed seed business model.

3. Understanding Seed Business in the Context of Smallholder Farmers

3.1 Seed market and smallholder agricultural production

For smallholder farmers, seed is the most valuable asset. In many countries of sub-Saharan Africa, smallholder farmers account for 80 to 90% of food production and in Tanzania and Uganda, they represent about 85%. Unfortunately, very few have access to seeds of improved varieties that are well adapted to diverse agro-ecological zones. Access to quality seeds is even more challenging for farmers in remote areas as agricultural dealers do not operate in those areas.

A visit to Agro-dealers, unravels the enormous mismatch that exists between the supply and demand of improved varieties of seed, indicating the untapped business opportunities for seed producers and seed companies.

Grain legumes, mainly groundnut and common bean offer important opportunity to improve productivity and livelihood of smallholder farmers. The contribution of these two legumes to food security and household income is substantial. Groundnut contains 40-50% of fat and 20-30% protein. It is consumed directly as confectionery (eaten raw, roasted or boiled) while the oil extract is used for culinary purposes in addition to animal feed. Agricultural intensification especially in the four legumes, is a good avenue to improve livelihoods of smallholder farmers. Poor quality seed undermines crop yield and hinders sufficient production, to cover domestic consumption and sale in the market. Due to this, smallholder farmers are unable to meet their financial needs.

During a stakeholder workshop of the Eastern and Southern Africa smallholder Farmers’ Forum (ESAFF) in 2014, an officer from the Ministry of Agriculture Food Security and Cooperatives, Tanzania, reported that, only about half (60000 tons) of the actual seed demand by farmers is met with about half obtain through seed import. However, the potential seed needed by farmers’ in Tanzania is more than 4 times the current supply (about 120000 ton). These figures indicate the need for further efforts to produce and distribute more seeds of quality. Planting of improved seed is a major step towards increasing smallholder agricultural production in developing countries.
3.2 Poor use of improved seed by smallholder farmers, uncertainty of their seed demand, and particularities of legume crop seed

Recent studies on farmers’ use of improved varieties report, that more than 80% farmers in sub-Saharan Africa still rely on seeds other than improved seed for crop production. Seeds borrowed from neighbors, farmers’ saved seeds or informal market seeds continue to be the main sources of planting material for smallholder farmers. High price, poor awareness of improved seeds and technical knowledge, are key factors leading to insufficient use of improved varieties by farmers. Affordability and availability of improved seeds is vital to enhance smallholder farmers’ use of improved groundnut and common bean seed varieties. According to several 2014 reports, 90% and 80% of the seeds planted (including groundnut) in Tanzania and Uganda, respectively, were obtained from the informal seeds sector and mainly from seeds, farmers’ had collected from their previous harvest.

In Tanzania and Uganda, the demand of seeds by smallholder farmers fluctuates every year because of their agricultural practices. When it comes to self-pollinating crops like groundnut and common bean, the seed replacement rate is low because the rate of recycling by farmers is high, resulting in lack of commitment by seed companies to produce seed varieties. Groundnut has high seed ratio, and a low seed multiplication rate (Table 1) of about 1/10, hence the planting of one hectare requires about 100 kg groundnut seed. Being an oilseed, conserving groundnut after harvest becomes challenging. These factors hinder investments by seed companies in groundnut seed businesses. In addition, the seed purchase price burdens smallholder farmers (about 2000 to 3500 Shillings for groundnut or about USD 1 to 1.6) in Tanzania.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Average seed rate (kg/ha)</th>
<th>Average multiplication ratio</th>
<th>Average yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut</td>
<td>100</td>
<td>10</td>
<td>1000</td>
</tr>
<tr>
<td>Common bean</td>
<td>70</td>
<td>15</td>
<td>1000</td>
</tr>
<tr>
<td>Sorghum</td>
<td>12</td>
<td>100</td>
<td>1200</td>
</tr>
<tr>
<td>Maize</td>
<td>15</td>
<td>100</td>
<td>1500</td>
</tr>
</tbody>
</table>

3.3 Public and private seed companies and categories of farmers reached with seeds of improved varieties

Public seed companies are government operated entities. They draw most of their resources from state funds and development organizations for their activities. As public agencies they are involved in many crops neglected by private companies. This is the case of Agricultural Seed Agency (ASA) in Tanzania. Private seed companies are profit-motivated entities and do not engage in seeds of a crop without a clear market scheme. Often private seed companies stay away from self-pollinated, open-pollinated, and vegetative seed crops. Sometimes even though the breeder seed is made available, they still request funds to produce the foundation seed. By 2014, 56 and 23 registered seed companies were operating in Tanzania and Uganda respectively, but very few of these seed companies invested in groundnut seed production and marketing. For most of them, maize and more importantly hybrids accounts for up to 90% of their business.

While public seed enterprises are likely to reach farmers in remote areas, it is not the case for private seed companies as they produce most of the seeds on contract basis. Private seed companies work with large scale farmers, Governments or development organizations that contract them to produce seeds for distribution to smallholder farmers.

3.4 What it entails to run a seed business in the context of smallholder farmers

Engaging in seed business in the context of smallholder farmers requires producing sufficient seed and making them available at the market place. Often times, entities involved in seed business focus on seed production and distribution, but fall short to effectively market their products as the demand for seeds by
smallholder farmers is inconsistent. To overcome this, a clear market scheme involving large seed buyers (e.g., NGOs or religious organizations), is required. In addition, it is necessary to create awareness among smallholder farmers through demonstrations, appropriate packaging (e.g., small pack), agricultural shows or exhibitions and proximity production involving farmer groups and cooperatives. Most importantly, moving seeds closer to smallholder farmers, including those in remote areas is a vital step to help expand the existing market reach.

Most seed companies raise concerns about poor seed market with smallholder farmers, but hardly take appropriate steps to create and increase the seed demand through planning and implementing awareness activities. It is obvious that the cost involved in creating awareness and moving the seeds to remote areas might be unbearable for small seed companies. Nevertheless, seed availability and awareness creation activities are relevant avenues to facilitate the growth of seed business in a sustainable way. Large seed companies are conscious of these and many of them have taken serious steps in that respect to maintain and expand their seed business. It is beneficial for small seed companies to partner with peer seed companies and with projects on seed development as a way to share awareness creation charges. This kind of partnership is being promoted by ASA and TL III in Tanzania.

3.5 Seed business objective

Seed business involves all activities related to acquisition of inputs, production, harvesting, processing, storage, promotion and marketing of seed to obtain profit. Except few, public sector seed agencies respond to shock or natural catastrophes with an aim to solve social problems, any seed enterprise intends to maximize profit through cost reduction and minimizing risks. This is one of the main reasons why seed companies produce seed for development organizations or farmer organizations on contract basis. To keep the business running, seed enterprises, also need to maintain a high level of seed quality to avoid disappointment of customers that might induce misfortune and even shutting down of business.

For farmer seed groups or individual seed producers, seed business is a means to raise household incomes through seed sales. It is also an opportunity to guarantee that high yielding quality seeds are planted. For farmers who are also seed producers, it is a means, to secure quality planting material for the next growing season.

To effectively deliver the objectives of a seed business, clear targets must be set (e.g., produce and sell 10 tons a year). It is important to have, clear production actions that lead to production of quality standard seeds (including employee care and training), good marketing strategies (high attention to customers and promotion activities), and to have initiatives to expand market reach (working toward engaging new market segments, and developing new products that fit consumer needs).

3.6 Components of a comprehensive seed industry

Seed industry has three major components namely: agricultural research; control and policy; and seed multiplication and marketing. Agricultural research can be done by public or private institutions and the main responsibilities are generating new cultivars, complementary technologies and cultivar maintenance. The main functions of control and policy component, are cultivar testing and release, inspection and certification. This is done by the seed regulatory authority, which in most cases, is an arm of the government. The seed multiplication and marketing component, is often a collection of individuals (or groups) and public and private institutions that are involved in the promotion and distribution of seed materials of various released (recognized) cultivars that are distinct, uniform and stable.

Seed producers often set up internal quality control systems, based on their own resources such as, sufficient knowledge and understanding of the seed production standards (Figure 1). Ideally, internal quality control systems are to be guided by the national tolerance levels and are meant to reinforce the national regulation and standards on seeds.
Figure 1. A typical flow chart for certification.
4. Principles of Seed Production and Management, Processing, Testing, Marketing and Interplay with Value Chain Actors

4.1 Principles of seed production

4.1.1 Definition of terms

a) Seed

As per the botanical definition, seed is: a resting embryo plant surrounded by a seed coat and may have an endosperm. The agricultural definition portrays seed as any part of a plant used for propagation purposes, e.g., true seed (botanically), cuttings, buds, bulbs, tubers, corms, and roots.

The technical definition of a seed perceives it to be, plant material used for propagation purposes and produced as per strict regulations to meet specific quality standards.

Note: The most important feature of a seed is that it is the means of perpetuation of the characteristics of defined groups or individuals (variety). For this purpose, it has to be a ‘living entity’ and therefore it requires careful handling to realize its full potential when planted.

There are two seed classes:

(i) Standard seed

Seed which has not been produced under the seed certification scheme, but has been tested, and complies with standards.

(ii) Pedigree seed

As the name suggests, the seed has a history (or lineage) and can be traced back to parents.

In the context of international trade, two systems of seed classification are recognized under pedigree seed. Both systems have four generations and use different nomenclature (Table 2).

<table>
<thead>
<tr>
<th>OECD1</th>
<th>AOSCA2</th>
<th>Produced from</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-basic seed</td>
<td>Breeder Seed</td>
<td>Breeder seed</td>
<td>Direct control of the sponsoring plant breeder or originating research station. The highest level of genetic purity.</td>
</tr>
<tr>
<td>Basic Seed</td>
<td>Foundation Seed</td>
<td>Breeder or Pre-basic seed</td>
<td>Limited to selected growers approved by the certifying authority.</td>
</tr>
<tr>
<td>Certified seed, 1st Generation</td>
<td>Registered seed</td>
<td>Basic seed or higher class</td>
<td>Should NOT be more than two generations from basic seed.</td>
</tr>
<tr>
<td>Certified seed, 2nd Generation</td>
<td>Certified seed</td>
<td>Certified 1 or higher class</td>
<td></td>
</tr>
</tbody>
</table>

1 OECD = Organization for Economic Cooperation and Development.
2 AOSCA = Association of Official Seed Certifying Agencies.

Quality Declared Seed (QDS)

This is a fairly new formal class of seed in some countries. The concept is to reduce the rigor of certified seed production and offer a less difficult, implementable quality assurance system, making quality seed easily accessible. In QDS production, the number of inspection visits are reduced and only 10% of the crop in the field and seed in the market may be inspected and tested.
b) Plant variety

A variety is a subdivision of species, that is, a naturally occurring group of individuals within a species which are distinct in form and/or function from other similar groups of individuals. An agricultural variety (cultivar = cultivated variety) is an assemblage (through human effort) of cultivated plants which is clearly distinguished by various characters (morphological, cytological, chemical, etc.) and which when reproduced (sexually or asexually) retains those distinguishing characters. There are many types of cultivars ranging from open pollinated to complex hybrids, but ‘cultivars of self-pollinating’ crops are good examples of inbred lines in which all members have descended by self-fertilization from a single homozygous individual. Cultivars and varieties need seed to perpetuate.

c) Seed lot

A stated portion of seed assumed to be reasonably uniform. Where outgrowers are used, a seed lot refers to the quantity of seeds produced by a single outgrower from a relatively uniform field under a uniform environment (management practices, inputs and environmental conditions). The maximum size of the seed lot varies depending on the species and is defined under the International Seed Testing Association (ISTA) rules. Seed lots exceeding these maxima must be reduced into smaller identifiable lots.

d) Primary sample

A small quantity of seed taken from a single position and when put together, these form a ‘composite sample’ from which a ‘submitted sample’ is drawn. A ‘working sample’ is the sample, on which laboratory tests are performed.

4.1.2 Importance of seed production

Seed is a key element in crop production. All cultural practices are designed to exploit the full genetic potential of the sown seed. No agricultural practice (tillage, cultivation, weeding, irrigation, fertilizer application) can improve a crop beyond the limit set by the seed planted. The crop may be poorer than the seed planted but it cannot be better. Seed, is therefore the baseline for success or failure in crop production. Poor seed may be associated with low yields and low returns clearly exposing that: ‘good seed makes you money, while poor seed costs you money!’

For successful farming, a farmer should start off with seeds of adapted cultivars with the following important quality components: (1) genetic purity, i.e., pure as to cultivar and kind of crop; (2) physical purity, i.e., no foreign or inert material; and (3) physiological soundness, i.e., good germination and high vigor. These are made available through robust seed systems in comprehensive seed industries.

4.1.3 The Seed certification process

The process of seed certification is designed to maintain the genetic purity of superior cultivars, as well as to set reasonable standards of seed quality and conditions. Prime consideration is given to cultivar (genetic) purity, viability, seed borne diseases, weed seeds, and also to grading and mechanical considerations.

Seed crop certification is a stepwise process of planned production which includes, record keeping, unbiased inspections, and rigid standards to ensure the production of high quality, cultivar-specific seeds. The purpose of seed certification is to maintain and make available to farmers, high quality and genetically pure seeds of superior cultivars. Inspections ensure that the cultivar under multiplication is true to type (varietal purity) and that the seed crop, is in a healthy condition without potential to transmit diseases, pests and noxious weeds.

Inspections are undertaken on the basis of preset standards, provided by the OECD Scheme for Varietal Certification to maintain and safeguard varietal identity and purity.
Certification procedures are based on standards for growing conditions, field isolation, crop inspections, prevalence of weed seeds, proportion of defect seeds, germination percentage and seed moisture content. If a seed field or seed lot does not meet the prescribed standards for the intended seed class, it will be rejected for certification.

Field inspections are required to verify the origin or source seed, identification of the cultivar, determination of the cropping history, adequacy of isolation distance (or time) and production practices. In addition, inspections ensure that all certification procedures are adhered to. Depending on the type of crop and cultivar, 3-10 field inspections are required during the season. This number can be higher for maize hybrids.

Following shelling or threshing, samples of seed are taken for laboratory tests to evaluate the purity of the seed, germination percentage and the moisture content. This is the final stage in the certification process, and if the seed lot passes all the standards, it is granted a ‘certified status’.

4.2 Managing seed production

4.2.1 Producing a seed crop following the certification standards

Management of a seed crop is similar to that of commercial crops, but higher levels of management are required in seed production. High levels of fertilizer management are necessary to maximize yield and quality, but the best guide is to follow the results from soil analysis.

Standards are based on the following:

- Previous cropping history of the field to evaluate the risk of undesirable volunteer plants of the same or related species contaminating the seed crop (for example, waiting periods can be one year for maize, bean and soybean, two years for groundnut and cowpea).

- Sufficient isolation from other crops to reduce the risk of contamination with undesired pollen, and admixture at harvest. Isolation by, distance and/or time, depends on whether the crop is: (1) cross- or self-pollinated, and (2) wind or insect pollinated (see Table 3).

- There should not be more off-type plants present, than allowed by the varietal purity standards (see Table 3).

- There should not be more plants of other species present than the standards allow.

- The seed crop should have the correct varietal identity.

| Table 3. Seed field certification standards with example of groundnut seed in Malawi. |
| Field Standards | Breeders/Basic | Certified |
| Minimum Inspections | 4 field: 2 post-harvest & 2 field | 2 post-harvest |
| Isolation | 10 meters | 5 meters |
| Previous cropping | No groundnut for 2 years | No groundnut for 2 years |
| Rogueing | No more than 0.1% off-type at any inspection | No more than 0.3% off-type at any inspection |
| Seed sorting | No more than 5% rosette infection at any inspection | No more than 10% rosette infection at any inspection |
| | No more than 0.1% undesirable shell/seed | No more than 0.1% undesirable shell/seed |
| | No more than 1% small/shriveled/damaged seed | No more than 5% small/shriveled/damaged seed |


### 4.2.2 Seed borne/seed transmissible and certifiable diseases

Seed borne diseases are plant diseases that start in the field on parts of the plant when conditions are favorable, but may, at a later stage, find their way into or on the seed. They can be transmitted from one crop generation to the next, through seed. The following are examples of tolerances for few certifiable diseases: **0.1% bacterial wilt and anthracnose** (common bean), **5% mosaic virus** (cowpea), **5% rosette virus** (groundnut basic seed), and **10% rosette virus** (groundnut certified seed).

### 4.2.3 Rogueing

The objective of Rogueing, an operation lasting throughout the growing season, is to get rid of undesired plants and maintain genetic purity of a seed lot. An off-type is an individual plant, exhibiting variation from the standard type of cultivar or strain. Rogues often arise from: volunteers, mutations, seed mixtures and diseases. All distinguishable off-type plants should be uprooted (to avoid tillers/suckers and new shoots), throughout the growing season, as soon as they are identified (better before they flower). In pre-basic and basic seed, there is **zero tolerance** to the presence of other crop seeds in the seed lot.

Table 4 summarizes the field standards for various seed crops discussed so far. The standards shown are developed for countries in the Southern African Development Community (SADC), but might be applicable to other countries, as the SADC region wishes to engage in international seed trade.

<table>
<thead>
<tr>
<th>CROP</th>
<th>Minimum isolation distance (m)</th>
<th>Maximum % of off-types (based on 1000 plants)</th>
<th>Minimum number of inspections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS (B)</td>
<td>CS (C)</td>
<td>BS (B)</td>
</tr>
<tr>
<td>Arachis hypogaea L.</td>
<td>Groundnut</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Cajanus cajan L.</td>
<td>Pigeon pea</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>Glycine max L. Merrill</td>
<td>Soybean</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Gossypium hirsutum L.</td>
<td>Cotton (H)</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td>Gossypium hirsutum L.</td>
<td>Cotton (OP)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Helianthus annuus L.</td>
<td>Sunflower (OP)</td>
<td>1000</td>
<td>800</td>
</tr>
<tr>
<td>Helianthus annuus L.</td>
<td>Sunflower (H)</td>
<td>3000</td>
<td>1500</td>
</tr>
<tr>
<td>Oryza sativa L.</td>
<td>Rice</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Phaseolus vulgaris L.</td>
<td>Beans</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Sorghum bicolor L. Moench</td>
<td>Sorghum (OP)</td>
<td>400</td>
<td>350</td>
</tr>
<tr>
<td>Sorghum bicolor L. Moench</td>
<td>Sorghum (H)</td>
<td>750</td>
<td>500</td>
</tr>
<tr>
<td>Triticum aestivum L. emend. Fiori et Paol.</td>
<td>Wheat</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Zea mays L.</td>
<td>Maize (OP)</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>Zea mays L.</td>
<td>Maize (H)</td>
<td>400</td>
<td>350</td>
</tr>
</tbody>
</table>

BS = basic seed, CS = certified seed, OP = open pollinated, H = hybrid
4.3 Managing seed processing and conditioning

Seed processing and conditioning, is a chain of activities, starting from harvesting to making seeds ready for final packaging. The processes involved include drying, pre-cleaning, cleaning, grading and seed treatment, all of which contribute to the acceptance of the final product: ready-to-plant seed. The number of processes and methods used in conditioning, depends on species, cultivars and available processing equipment. The objective of seed conditioning is to ensure preservation of desirable qualities (viability, germination capacity), enhancement of appearance and uniformity of seed.

Activities

a) Harvesting

The highest seed quality (viability and germination percentage) of any seed crop is at physiological maturity. However, at this stage the seed has a high moisture content, unsuitable for handling and therefore storage. It has to be dried to reduce the moisture content to suitable levels for harvesting, and to reduce vulnerability to disease, pest and physical damage. On the other hand, delays in harvesting should be avoided to reduce the risk of field pest infestation. Therefore, there is a harvesting window which offers the ideal conditions.

Hand harvesting of seed crops is most suitable as the use of machinery often increases seed damage and inclusion of inert matter. Beans (common bean, soybean, pigeon pea) must be harvested early in the morning to overcome losses from shattering in high temperatures.

b) Seed drying

Seed drying is undertaken to either, remove excess moisture content to maintain an equilibrium with normal atmospheric air, or to, maintain moisture content that decreases enzyme or insect activity over a period of time. Principally, there are two methods of drying seeds: natural and artificial. In both methods, heat is necessary to evaporate moisture and a flow of air is required to drive it away. During drying, there are three possible risks that may affect the long term viability of the seed: (1) drying too fast, (2) over or under drying, and (3) drying the seed slowly. As a general rule, the drying rate for seed should not exceed 0.5% moisture removal per hour to minimize seed damage. The rate of drying depends on the air temperature, the relative humidity of the air and the rate of airflow through the seed. Since seed is a living organism, the maximum air temperature for drying seed, depends on the initial moisture content and is lesser for commercial grain drying. Humidity level above 65% poses a serious risk to long-term storage of seeds, because the seed will gain moisture and become prone to deterioration, rotting and even sprouting. Ideally, seed producers should consider the costs and benefits of all available seed drying options.

c) Sorting, shelling and pre-cleaning of seed

After harvesting and drying, seed needs to be sorted. This refers to removal of diseased, damaged, malformed grain out of the ‘true to type’ seed and this often starts in the field (hand harvesting). Although hand shelling of seed gives the highest quality, this is not always economically feasible for huge volumes of seed. It is important to consider the amount of seed a worker can shell in a day for, maize, common bean, and groundnut. A number of machines may be available for improved speed and throughput of clean raw seed, but they may cause seed damage due to abrasion (seed coats rubbing on rough surfaces) and impact (amount of force applied to the seed). Since seeds need to be shelled at the appropriate moisture content (10-14%), the machinery should be calibrated to minimum speed to reduce damage (see Figure 2).

Raw seed will contain varying amounts of extraneous matter, damaged seed, and weed seeds, depending on production, harvesting and shelling methods. Therefore it is important to pre-clean before grading and treatment. The most basic method of pre-cleaning is by hand, either by handpicking unwanted material and seeds from the true seed, or with the use of simple winnowing baskets.
d) Seed treatment

**Objective of seed treatment**

The size and shape of the raw seed may not have the uniformity required by farmers. Seed may be treated with various kinds of chemicals to improve its appearance (e.g., dyes) and protect it from pests, diseases and weeds (with insecticides, fungicides and herbicides). In addition, performance enhancing products (e.g., growth regulators and nutrients) are added along with some colorants to the seed coat as a means of identification.

**Key factors for seed treatment**

*Coverage*, i.e., the evenness with which each seed is covered with chemical.

*Distribution*, i.e., the uniformity of chemical distribution throughout the seed sample. Depending on a number of factors, seeds within a seed lot, may have differing amounts of chemical applied. Seeds with low amount of chemical will not be adequately treated, whereas seed having too much chemical may show chemical damage symptoms.

*Overall seed loading*, i.e., the total amount of chemical on the seed should be according to the specified dosage rate (Table 5).

<table>
<thead>
<tr>
<th>Table 5. Some common fungicides used for seed treatment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
</tr>
<tr>
<td>Maize, sorghum</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Beans</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Wheat, rice</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

---

\(^1\) FW = Flowable; Finely ground powder of a solid active ingredient suspended in liquid which prevents settling out

\(^2\) WP = Wettable Powder: Finely ground active ingredient plus carrier which will assist the formation of a suspension in the spray tank, maintained by constant agitation during spraying

\(^3\) Maxim XL 035 FS\(^5\) is a registered product of Syngenta Agro Services which contains 35g/L of a mixture of fludioxonil + metalaxyl. The product is formulated as a flowable concentrate for seed treatment (FS)

\(^4\) Baytan 15 WP\(^6\) is a registered product of Bayer Crop Science which contains 15g/L of triademenol. The product is formulated as a wettable powder (WP)
Summary of seed conditioning

Physical property variations are critical in seed cleaning, grading, and separation of seed fractions during the conditioning processes, for instance, densities for use of blowers and sizes for grading. In a seed lot, the removal of low quality seeds, improves the average quality of the remaining seed. Measurement of physical and biochemical properties forms the basis of quality control and process monitoring. When an equipment is used in seed conditioning, it has to be calibrated to minimize losses.

4.4 Managing seed marketing

4.4.1 Marketing mix

For a seed business to flourish, producing seed is not sufficient, seeds that are produced need to reach customers. A good seed company should know, how to market its product and bring value to customers.

Marketing is then a process of identifying, anticipating, and supplying requirements of customers in an efficient and profitable manner. It is an all-embracing function that links business with customer needs and wants, in order to get the right product to the right place at the right time. While a business should always be about customers, entrepreneurs should also think about profitability to keep the business going.

More often than not, it is assumed that marketing is simply placing a product on shelf for sale, however marketing entails: (1) planning and allocation of resources, i.e., what enterprises to pick, varieties selection etc., (2) advertising and promotion, i.e., clients need to know about products and be enticed, (3) market research, i.e., what are the needs, where are the gaps, and (4) distribution network and actual sale, i.e., product placement and customer care. All these can be summarized in the marketing mix: product, place, price, and promotion.

Place: (a) Know your market, i.e., who is your market? Where is your market? (b) Know your customers and their needs.

Product: Know your products and their characteristics, i.e., how does your product meet your customers’ needs? What benefits does your product give to the client?

Price: (a) There is a myth that a new business must always sell at lower price compared to the rest. What determines pricing? How do we make seeds more affordable? How do we reduce production costs – to reduce selling price? (be aware that more than 60% of the price is production cost)

Promotion: (a) Place your products near your customers, (b) Product awareness through product catalogues, product specific attributes and benefits, (c) Field demonstrations, (d) Product specific advertisements, (e) Posters, (f) Packaging, and (g) Providing customer service e.g., advisory services to support purchase and use of quality seed.

4.4.2 Understanding customers and their needs

Farmers are diverse and generalizations may not apply all the time. It is important to ask questions like: What crops are farmers interested in, what varieties? Why?

Farmers have varying income levels, priorities and therefore, pricing and affordability may vary. Just like any other customers, farmers want to purchase at their convenience, which is determined by geographic location, timing of seed availability, and size of packaging. To facilitate this, a wide distribution network is necessary. For most farmers, ‘seeing is believing’. Marketing efforts with visual elements during interactions with farmers often give better responses. Demonstration plots remain a good way of showcasing varieties and quality seed. Most farmers are risk averse, and recommendations and endorsements from other farmers have a very important role to play in future sales. Farmers are rational and want a fair price for their product and usually look for the next available alternative if the seed
costs are high. For most self-pollinating crops including legumes, the fierce competitor to seed purchase is home-grown legume (farm-retained) seed for two main reasons: (i) saves production costs, and (ii) ensures timely availability of seed.

**Note:** Retention of seed from hybrid crops should be avoided at all costs. For example, with maize, the use of second generation seed of single cross, three way and double cross hybrids results in **yield reductions** of 46%, 32% and 19% respectively. However, with improved open pollinated varieties (OPVs), there might only be a 5% yield penalty from using farm-saved seeds compared to fresh seeds.

**Traditional disadvantages of using farm retained seed**

- **Reduced varietal purity:** Physical mixture of cultivars often takes place on farms and is quite noticeable in groundnut, and beans where a lot of cultivars have differently colored seeds. At times, farm saved seeds are **contaminated with weed seeds.**

- **A farmer retaining seed does not benefit from new cultivars regularly released into the market.** New cultivars of major crops are released fairly frequently and the only way to acquire these is to purchase seed.

- **Poor physical quality:** Farm retained seeds are usually of poorer physical quality and ungraded seeds have to be thoroughly cleaned and graded with specialized equipment in addition to, being treated with seed protectants (e.g., fungicides and insecticides).

- **Poor viability and vigor:** Farm retained seeds often have low viability and vigor because of poor storage conditions, insect damage etc. This impedes germination, triggers growth with poor plant stands and weed problems. Any seed sold, must have, by law, a minimum germination standard and certified seeds have a higher standard of germination.

- **Seed-borne diseases:** These can increase in-farm retained seed due to lack of adequate/appropriate seed treatment. Seed borne diseases often cause poor plant stands and high production costs. Some seed borne diseases can reach epidemic levels unless seed crops are carefully inspected and vigorous standards are applied as in a certification scheme.

### 4.5 Sampling seed for laboratory testing

Sampling is the extraction of a small quantity of seed representative of a particular seed lot. The objective is to pick representative fractions that can be reliably used to make inferences on properties of the seed lot in question by measuring the actualities of submitted samples.

The measure of seed quality in observation field plots and laboratories is based only on samples. The results of these tests form the basis for trade in seed including international trade. It also determines the issuance of seed certificates, national seeds legislation and technical decisions by the producer and consumer. The reliability of the inferences made about the seed lot depends chiefly on the accuracy with which the sample represents the seed lot and the precision with which the laboratory tests are done. Incorrect sampling leads to misleading test results and should be avoided because, high quality seed lots might be discarded or low quality seed lots might get approved.

Sampling for laboratory testing has to be done after the seed has passed through commercial cleaning and some level of processing, which would then give the seed lot, adequate degree of uniformity for the sampling techniques, thereby resulting in the generation of representative samples.

#### 4.5.1 Picking a representative sample

It is practically impossible to get a perfectly uniform seed lot. If this were possible, then it would be sufficient to pick a sample from the seed lot based on convenience. However, due to limited uniformity within seed lots, certain prescribed sampling procedures have to be followed to obtain a sample as close as possible to the seed lot in order to make inferences meaningful.

Analysis results will only reflect the quality of the submitted sample.
4.5.2 Sampling bags or other smaller containers

a) Nobbe type and sleeve trier (dynamic spear)

This is a pointed metal tube, with a hole along the tube. It should be long enough to reach the center of the container (Figure 3). When sampling from upright or horizontal bags, the trier must be inserted diagonally across the bag from top to bottom, to ensure collection of seed from the entire cross-section of the bag, catering for segregation that might have occurred during bag filling. The trier must be inserted with the openings closed until the bottom of the bag is reached.

b) Sampling by hand

When the above tools are not available and also, when handling chaffy seeds, sampling by hand may be the only satisfactory method. Primary samples must be taken by removing handful of seeds from random positions. It is necessary to pick primary samples from the lower layers in bags to ensure a representative sample. This might mean partially emptying the bag first. When sampling by hand or using the dynamic spear, portions of seed should be taken either from the top, middle or bottom of each selected bag and the positions must be varied, so that seeds are taken from different vertical positions.

Number of sample units

When sampling from bags and containers weighing less than 50kg it is recommended that these are combined to 100kg units, see Table 6 below.

Table 6. Sampling frequency for bags and small containers.

<table>
<thead>
<tr>
<th>Number of containers in the lot</th>
<th>Minimum number of containers to be sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 (inclusive)</td>
<td>Each container, portions being taken from at least 5 positions</td>
</tr>
<tr>
<td>6-14 (inclusive)</td>
<td>Not less than 5 containers</td>
</tr>
<tr>
<td>15-30 (inclusive)</td>
<td>At least one container in 3</td>
</tr>
<tr>
<td>31-49 (inclusive)</td>
<td>Not less than 10 containers</td>
</tr>
<tr>
<td>50-400 (inclusive)</td>
<td>At least one container in 5</td>
</tr>
<tr>
<td>401-560 (inclusive)</td>
<td>Not less than 80 containers</td>
</tr>
<tr>
<td>561 or more</td>
<td>At least one container in 7</td>
</tr>
</tbody>
</table>

4.5.3 Objective of seed analytical tests

Seed analytical tests intend to make inferences on properties of the seed lot in question, by measuring the actualities of submitted samples. Analytical tests are undertaken in seed laboratories equipped with facilities that are used in seed testing. The analytical tests generally include: germination, purity, and moisture content, and on request, tetrazolium, vigor and seed health tests. The analysis is done by seed analysts, who are sufficiently equipped with relevant skills. These laboratories may serve the national requirement or may be ISTA accredited.

Relevance of seed analytical tests

Seed buyers and users would want to know the quality of seed on which they are spending money. It also guides seed producers (companies) on the quality of seeds they have produced. If it does not meet the standards required, further seed cleaning can be done or it can be downgraded to grain and sold at a lower price when the quality is declared. Sometimes analytical tests particularly the purity test is requested by humanitarian organizations that supply relief food.
Critical properties of seed

Certified seed must meet certain laboratory standards. These are summarized in Tables 7 and 8.

Table 7. Example of summarized seed laboratory standards (SADC Harmonized).

<table>
<thead>
<tr>
<th>CROP</th>
<th>Laboratory standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botanical name</td>
<td>Common name</td>
</tr>
<tr>
<td>BS</td>
<td>CS</td>
</tr>
<tr>
<td>Arachis hypogaea L.</td>
<td>Groundnut</td>
</tr>
<tr>
<td>Cajanus cajan L.</td>
<td>Pigeon pea</td>
</tr>
<tr>
<td>Glycine max L. Merrill</td>
<td>Soybean</td>
</tr>
<tr>
<td>Oryza sativa L.</td>
<td>Rice</td>
</tr>
<tr>
<td>Phaseolus vulgaris L.</td>
<td>Beans</td>
</tr>
<tr>
<td>Sorghum bicolor L. Moench</td>
<td>Sorghum (OP)</td>
</tr>
<tr>
<td>Sorghum bicolor L. Moench</td>
<td>Sorghum (H)</td>
</tr>
<tr>
<td>Zea mays L.</td>
<td>Maize (OP)</td>
</tr>
<tr>
<td>Zea mays L.</td>
<td>Maize (H)</td>
</tr>
</tbody>
</table>

BS = basic seed, CS = certified seed, H = hybrid, OP = Open pollinated

Table 8. Complete quality characteristics for a seed crop (example: certified maize seed in Zimbabwe.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Quality standard (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Cultivar purity, by weight (minimum)</td>
<td>99.0</td>
</tr>
<tr>
<td>(b) Individual weed seed, by count (maximum)</td>
<td>0.2</td>
</tr>
<tr>
<td>(c) Total weed seed, by weight (maximum)</td>
<td>0.5</td>
</tr>
<tr>
<td>(d) Prohibited weed seed, by count</td>
<td>nil</td>
</tr>
<tr>
<td>(e) Other crop seed, by weight (maximum)</td>
<td>0.1</td>
</tr>
<tr>
<td>(f) Distinguishable off-types, or other cultivars, by weight (maximum)</td>
<td>0.1</td>
</tr>
<tr>
<td>(g) Insect damaged seed, by weight (maximum)</td>
<td>3.0</td>
</tr>
<tr>
<td>(h) Damaged seed, by weight (maximum)</td>
<td>1.5</td>
</tr>
<tr>
<td>(i) Total of (g) and (h) above, by weight (maximum)</td>
<td>3.0</td>
</tr>
<tr>
<td>(j) Live insects in seed, by count</td>
<td>nil</td>
</tr>
<tr>
<td>(k) Immature and undeveloped seed, by weight (maximum)</td>
<td>1.0</td>
</tr>
<tr>
<td>(l) Inert matter, by weight (maximum)</td>
<td>1.0</td>
</tr>
<tr>
<td>(m) Germination, by count (minimum)</td>
<td>90.0</td>
</tr>
<tr>
<td>(n) Moisture content, by weight</td>
<td>13.0</td>
</tr>
<tr>
<td>(o) Molybdenum (minimum)</td>
<td>0.083ppm</td>
</tr>
</tbody>
</table>

Purity analysis

It is the percentage composition by weight of the sample being tested, and by inference, it is the composition of the seed lot, the identity of the various species of seeds and the inert particles constituting the sample.

Analytical purity is the most important component of seed quality. It indicates how much of the seed material of the species, named on the label is intact (see Figure 4). It protects farmers against the use of impure and adulterated seed contaminated from other crop species, inert matter etc. Analytical purity
has definite standards for various crop species, generally not less than 98%. Weights of all component fractions from the working sample have to be added together for comparison with the original weight to check for losses or gains in weight. In the event of a discrepancy of more than 5% of the original weight, a retest must be done and the result of the retest then reported instead. The percentage by weight of each of the component parts has to be expressed to one decimal place. The percentages must be based on the sum of the weights of the components, not on the original weight of the working sample.

**Note:** Nowadays cultivars, inbred lines, etc., can be verified through polyacrilamide gel electrophoresis (PAGE), a technique commonly referred to as genetic fingerprinting.

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**Germination test and procedure**

Germination of a seed in the laboratory is the emergence and development of the seedling to a stage where the aspects of its essential structure indicates, whether or not it is able to develop further into a satisfactory plant, under favorable field conditions. The main objective is to determine the maximum germination potential of a seed lot which can be used to compare the quality of different lots and estimate the field planting value. A laboratory test is used, because it can be repeated with reliability.

Germination test is made with seeds from the pure seed fraction of the purity test. Sample for this test is obtained by dividing the submitted sample to obtain working sample for purity test.

The substrates used include, sterilized lake sand, top of paper (TP) and between papers (BP) (see Figure 5). When using sand, it is recommended that, the sand be changed every two years. The choice of substrate is guided by the seed size and how delicate the seedlings are likely to be. Seedlings are evaluated one week from the day the test was initiated (first count) a second count may be made if seeds do not all germinate. The analysis is done by careful removal and examination of seedlings particularly the development of the root and shoot systems and are accordingly categorized as per the stated procedure. Results are expressed as percentage by number of normal seedlings, similarly, the percentage of abnormal seedlings, and dead, hard and fresh seeds.

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*Figure 4. Purity analysis underway. Specimen under the purity lamp (left) and separation (right).*
4.5.4 Determination of moisture content

Moisture content is very important. It is the key factor in determining whether or not the seed will retain its germination from harvest to sowing time. The oven dry method is the most accurate method for determining moisture. Moisture meters offering quick on the spot assessment of moisture, must be checked against this standard. The moisture content of a sample, is the loss in moisture, expressed as a percentage of the original weight of the sample when it is dried in accordance with the prescribed procedures. The methods for moisture content determination are designed to reduce oxidation, decomposition or the loss of other volatile substances while ensuring the removal of as much moisture as possible. Large seeds (including groundnut and common bean) must be ground, before drying as their high oil content make them difficult to grind or liable to gain in weight through oxidation. It is obligatory to dry the seeds when moisture content is more than 17% (or, 10% in the case of soybean and 13% in the case of rice).

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

\[
\frac{(M_2 - M_3) \times 100}{M_2 - M_1}
\]

M1 is the weight in grams of the container and its cover; M2 is the weight in grams of the container, its cover and its contents before drying, and; M3 is the weight in grams of the container, its cover and contents after drying.

The result must be the arithmetic mean of the duplicate determinations carried out on a sample if the difference between the two determinations does not exceed 0.2%. Otherwise, the determination has to be repeated in duplicate.

The moisture content must be reported to the nearest 0.1% on the certificate.

Figure 5. Seed germination test substrates, pleated paper (left) and sand (right).
4.6 Interplay between seed operations, value chain actors, innovation platform & partnerships

Output product definition, inputs acquisition, production management, harvesting, processing, storage, marketing and quality control of seed represent major operations that underpin quality seed delivery to end-users. Each operation is executed by specialized categories of actors operating at each stage of the value chain: from inputs supply to the consumers’ table. The value chain actors part of the innovation platform (IP), need to commit and take collective action to ensure different operations are executed and appropriately implemented. A successful seed business would require a close collaboration between different value chain actors taking action within the IP, to ensure that: inputs are available to seed producers and farmers, production is conducted appropriately using good and more productive agricultural practices, post-harvest activities meet the calendar, marketing arrangements benefit all market agents, and the quality standards are met (Figure 6). The platform interventions will particularly streamline the market arrangements for strong seed and grain business environments. Essentially, each commodity value chain will expand and become a strong business providing livelihoods to a large number of stakeholders.

Partnership arises when, two or more entities deliberately come together to share management and benefits. In partnership there is synergy, where ‘1 + 1 > 2’: meaning, performance of the combination is higher than that of the sum of the individual elements. This enables each partner to use resources, where they have sustainable competitive advantage. Therefore it is critical to decide why, when, and how to partner with others for complementarity and enhanced efficiency.

Partnership facilitates pooling together a variety of resources, which a single partner might not adequately address, such as: necessary experience, knowledge, investment, and technologies to address productivity, income, nutrition, and resilience issues. One key area for partnership is information and technology development. Provision of seeds to farmers is not enough. It is essential to provide them information on varieties to aid in variety selection and to continuously improve decision making and benefit from sustainable agricultural practices.

Figure 6. A simplified example of the interplay between seed operations, value chain actors and innovation platform (adapted from Rubyogo, personal communication).
5. Resource Requirements and Mobilization for Managing a Seed Enterprise

5.1 Resources required to set up a seed business

Starting any business requires resources, often based on the start-up scale. Similar to any other business, there are basic resources required to start a seed business. The most critical resources can be classified into three: germplasm, know-how, and capital. Seed business requires staff that are knowledgeable in the three areas.

Germplasm

Public varieties are available for start-up seed companies without royalties in most countries of sub-Saharan Africa (SSA). In SSA, it is only in southern African part, where there is exclusive licensing of legume varieties, but several other countries are pursuing the same approach. Start-up seed companies may either, choose to take in their portfolios and public varieties that are already popular (riding on others’ promotion efforts), or choose to promote completely new and unique varieties. Either way, the variety has to fit well into the companies’ ‘products’ under the marketing mix of 4Ps.

Technical know-how

Seed business requires good knowledge of not only, technical aspects of seed production but also, of business and finance. The capacity to handle this type of business is not always present. Recognizing these gaps, a number of institutions such as CGIAR centers and Alliance for Green Revolution in Africa (AGRA), have developed mechanisms to support capacity building of start-up seed companies in seed production, networking, development of business plans, and other relevant aspects. Technical understanding of business operations and sophisticated equipment indubitably comes with experience.

Capital

Start-up costs are the costs required to begin a business. Every business requires money to operate. Money to meet these costs may come from personal savings, money from relatives or friends or money borrowed. Capital is used to buy assets, employ staff and generate products or services for sale. An entrepreneur in a seed business should be aware, that it may take some time to start reaping the benefits and should ideally delay taking profits out of the business (1000 days rule). Capital can split into two categories: capital for overheads, and working capital.

Working capital is critical for keeping the business running. Businesses may continue to run while making low profits, but they certainly close once they run out of working capital. Working capital determines what activities can be carried out, hence the famous adage ‘cash is king!’

5.2 Seed treatment equipment

Apart from finance, one of the most frequently asked questions relates to seed conditioning facilities. It is a regulatory requirement that all seed should be treated before being sold. The nature of the treatment determines, the type of equipment that can be used for the operation. Seed treatment equipment should be a long term investment, therefore while purchasing, it is prudent to check the capacity and functionality of the equipment, as it will still be relevant to the organization for at least 10 years. Most start-up seed companies begin with simple, locally fabricated seed treatment equipment (e.g., rotating drum or old concrete mixer) and later on invest in hi-tech seed processing plant.
5.3 Seed storage space

Typically, after conditioning, seeds need storage before sales begin or during peak periods. Seed warehouses need to be spacious, well ventilated, with a leak-proof roof and an impervious floor. Preferably, the sides of the warehouse should be enclosed to reduce seepage during rainfall and to provide security.

Seed may be stored in bags for lengthy periods, provided the seed has moisture content of less than 13%, the storage conditions are favorable for maintaining seed viability (i.e., cool and dry), the seed is protected from storage pests, bags enable gaseous exchange and are stacked in an orderly manner. Seed is a valuable product, and therefore the warehouse must be secure from the risk of theft.

How critical is storage space

Storage conditions will at best, keep the seeds at their initial quality, however it cannot improve seed quality, no matter how good the facilities are. Therefore:

1. Major cause of poor seed coming from any storage is poor quality seed placed therein;
2. Seed stored at high moisture content will lose viability rapidly. There is a strong negative correlation between seed moisture content and seed storage life. For most field crops, the seed moisture should be less than 12.5% for safe storage. No seed should be out in storage unless its moisture content is low enough to maintain seed quality;
3. If seed is kept for too long in storage, its quality deteriorates. Time is a very important factor. Seed is a living specimen and therefore, it ages with time, losing viability and its quality attributes. It is important to follow the first-in, first-out rule in seed warehouses to avoid having seeds staying too long in storage;
4. Some crop species naturally lose viability rapidly, for instance, soybeans, groundnuts and other oilseeds;
5. Poor storage conditions also lead to loss of viability. Unsuitable conditions such as poor ventilation, predisposition to heating, exposure to moisture will result in rapid loss of seed viability. As a general rule, if the relative humidity of the air is above 60%, seed deterioration is likely to be rapid. As such conditions will increase the moisture content of the seed and encourage the development of diseases and storage pests. Ideally, seed should be stored in a ventilated secure shed protected from rain and heat; and
6. Over handling of delicate seed such that it gets split or damaged: avoid throwing and rough handling of seed (especially, groundnut).

Seeds should not be stored near fertilizer, as fertilizer can attract moisture from the atmosphere damaging the seed.
6. Information and Communication Technologies and Seed Business Development

Information and communication technologies (ICT) are important tools, to convey relevant information to smallholders (farmers, traders, processers) throughout the country. Information and communication technologies are current means, used to support informed decisions on smallholders’ activities irrespective of their locations. Stakeholders in seed business need to have access to ICT services that address their needs. This is an effective way to bridge the knowledge and information gap and hence improve agricultural growth. In this section, we discuss the technology that is easily accessible to smallholders.

6.1 Key principles for digital development

The following principles should guide the design of a digital ICT tool (adapted from Waugaman, 2016):

- Design with end-user in mind: address key issues hindering the intended users;
- Be collaborative: gather relevant expertise involved;
- Understand the existing system and context: build on existing structures (technologies and policies);
- Design for use at scale: target the larger number;
- Mind its sustainability: cost-effective and community ownership;
- Be data driven: information gathering for informed decision making;
- Make it a public good: accessible to public;
- Improve based on the use experience: make adjustments to make it more practical; and
- Take into account privacy and security issues: reduce risk to maximum.

6.2 Information and communication technology services tailored to smallholders

- Radio and television programs with farmers and other stakeholders as hosts: make it interactive with mobile phone call and messaging so that listeners can participate and ask questions about their own experiences;
- Short videos: peers describe their personal experiences with new practices or technologies;
- Text and voice messaging systems: well-crafted and targeted texts and graphic messages on planting time, harvesting period, storage or marketing time;
- Internet based services: use of social media e.g., WhatsApp, Facebook, Twitter, etc., to post relevant messages;
- ICT can be used to deliver a wide range of information to smallholders. For example information on: (1) weather forecast, (2) land preparation, (3) seed, (4) fertilizers and pesticides, (5) crop management, (6) postharvest, and (7) market.

6.3 Some cases of effective ICT service delivery for smallholders

- iShamba (i stands for ICT and Shamba for farm), is a call center of agricultural experts in Kenya, where you can SMS your questions or call to speak to an expert for instant help. Services include: call center, question and answers, agriculture tips, weather, market prices, and alerts on farm events.
- Esoko (E stands for electronic and soko for market in Kiswahili), is in many African countries such as, Kenya, Zimbabwe, Ghana, and Nigeria. This platform provides marketing and advisory solutions.
- LINKS (Livestock Information Network Knowledge System) database is in Ethiopia, Kenya and Tanzania. It provides information on prices and sales volumes for cattle across various regional markets.
- FARMIS (Farmer Record Management Information System) and Infotrade in Uganda, link farmers to the markets.
- AMITSA (Agricultural Input Market Information Systems) works in many countries including Tanzania. This is a regional agricultural input market information system platform that provides farmers and agricultural dealers with in-depth technical information about agricultural inputs.
7. Models of Seed Business Management for Smallholder Farmers

7.1 Approaches to seed dissemination

Seed dissemination in most countries of sub-Saharan Africa has been controlled by government agencies, mainly extension services with limited involvement of private sector. The few who have access to seed are large farmers, or the other few who have contact with extension services. It is known that the cropping acreage and subsequently the financial capacity of smallholder farmers do not allow them to purchase large amounts of seed. However, most of the time, seeds intended for smallholder farmers are packed in large amounts. In particular, smallholder farmers located in remote areas are simply excluded as there are no seed access points close to them and limited efforts have been made to reach them.

Recently, more efforts have been made to get a stronger involvement of the private sector. Many national and international organizations (NGO, research centers, CGIAR centers, Alliance for Green Revolution in Africa (AGRA)) are increasingly getting involved in developing seed dissemination models tailored to smallholder farmers. For example:

- Community-based seed productions are implemented to have seed available at the vicinity of smallholder farmers;
- Small seed packs tailored to smallholder farmers’ demand (e.g., 1, 2, 5, 10 kg seed packs) or larger for, medium and large farmers);
- Mali and Malawi have developed a system of seed revolving funds that supports commercial seed producers;
- Tanzania, Uganda and India have come up with a simplified quality seed production scheme i.e., limited seed certification rules, that allow the production of quality declared seed or truthfully labelled seed;
- Involvement of youth education entities such as, agricultural schools in seed production and distribution at the community level (e.g., Tanzania);
- Seed promotion activities that are executed by different organizations to create awareness through demonstrations, field days, exhibitions, agricultural shows, documentaries, printed media, radio, and television events; and
- Creating an enabling environment to facilitate seed access at the local and regional levels through seed regulation and harmonization.

All past and present seed dissemination approaches, have contributed to the spread of seeds, so that smallholder farmers can use and improve their livelihoods. To better harness the ongoing dynamics for increased seed use and higher smallholder farmers’ productivity, it is necessary to think of a more inclusive model that integrates many more aspects.

7.2 Inclusive model of seed delivery to a large number of farmers

Inclusive seed delivery covers farmers beyond the number of farmers reached by existing improved varieties. Farmers in remote areas represent a huge opportunity that are often left behind. More focus should be on them, including subsequent interventions like facilitation of access to financial services and other farm services detailed below.

Seed delivery to smallholder farmers should focus on issues beyond seeds. One should bear in mind that seeds do not stand alone and seeds market are driven by the grains market. To effectively disseminate seed, the target should also be at leverage points that expand the grain market.
When more grain is sold, the demand for seed will increase. Developing a seed market would involve prioritizing issues that hinder the grain market. In other words, an inclusive approach to seed delivery embodies current approaches to reach more farmers (different seed access models and awareness creation activities), and also developing support systems that resolve issues hindering the grain market (Figure 8). For example: (1) instead of focusing interventions on seed producers, farmers who use seeds to produce grains should also be targeted for training. Especially if they fail to meet grain quality standards that fit their market outlets, (2) some of the interventions should target access to inputs at the community level for improved productivity of promoted varieties, (3) smallholders should also be supported for credit systems if access to affordable credit is a major problem, (4) having in place a mechanism that mitigates the seasonal need of cash by farmers, would also be important, e.g., warranting their harvest to avoid low price sale during harvest or peak time, (5) access to market information is important, as farmers will be motivated to grow only those seeds that sell at the market, (6) technical knowledge of good agricultural practices is part of the package to expand seed used by large number of smallholder farmers, and (7) an emphasis on the development of entrepreneurial skills for actors in seed sector with a good linkage to different economic agents.

Seed business development tends to, overlook basic seed delivery in the system. It is important to have a win-win arrangement between different organizations involved, so that certified or quality declared seed producers change their mind to purchase early generation seeds.

![Figure 8. Components of an inclusive seed business development.](image)

### Inclusive seed business development for increased flow and use of improved legume (certified/QDS) seeds by smallholder farmers

1. Multi-channel seed promotion/ awareness creation activities
2. Motivated/win-win arrangements for availing early generation seeds
3. Smallholder farmers’ access to quality inputs: fertilizers & pesticides
4. Capacity building for smallholder farmers to meet market quality standards
5. Facilitating smallholders’ access to financial and other farm services
6. Interventions targeting access to market information
7. Entrepreneurship skills development for seed producers and agro-dealers

8. Developing a Seed Business Plan

A business plan is a reference document that clearly states its goals and is basically a roadmap that describes how to grow and expand the company, or a production unit. A seed business plan is then a working document where the goals and plans to grow and develop seed business are outlined. More importantly, the seed business plan can also serve as means to mobilize financial resources for the seed enterprise. Its presentation can convince the bank to provide well-adapted loan to the seed enterprise.

Developing a seed business plan involves answering the following questions:

(1) What is my production unit all about? What are its particularities or uniqueness and how will my unit look like in the near future, in three, five or even ten years’ time?
(2) What are the products/services my unit will be offering?
(3) Who are the people to use my products and where are they located? Who are my competitors, where are they located and what are they supplying?
(4) How do I reach customers? How do I choose the location of my unit such that my targets are reached and at the same time be economical?
(5) Do I conduct different activities alone or do I need help and at what cost?
(6) Do I have enough resource to start my business and if not, what are the existing affordable options?

Providing answers to these questions means discussing the purpose of the seed enterprise and working on product and or service delivery; tending to customers; engaging in promotion activities, investments, profitability, and human resources.

8.1 Key components of a seed business plan
The main components of a seed business plan are:
• Description of the unit/enterprise and vision statement.
• Description of products or services and what makes them different.
• Market analysis including competitors and plan to market the products or services.
• Description of the required human resources.
• Financial resources and cash flow statement.

8.2 Highlights of each component of seed business plan

8.2.1 Description of the seed unit/enterprise & vision statement
This section of the business plan provides background but relevant information on the seed enterprise. The types of professionals who own the seed enterprise, are presented to provide an idea of the professionalism it involves. The physical, phone and electronic contact, geographic representations of the seed enterprise need to be presented as well (alternatively show in the first/title page). If possible the best story people narrate about seed enterprises are reported here to show how satisfied former and current clients feel about our products and services. The objectives are clearly stated here as well.

The image of the seed enterprise or the group members operating in the seed business is also stated (e.g., supplying a certain amount of seed covering an area of the country, or in terms of production or income increase per group member involved in the seed business).

8.2.2 Description of products or services to offer and what makes them unique
The grades of produced seeds, their genetic superiority and agronomic characteristics are presented in this section. For example, this section can show that different varieties are drought-tolerant, have specific pest resistance (to be specified), high yielding (giving an indication of yield estimation), and other market-driven attributes like taste, color, cooking time, and potential to make confectioneries. Some illustrations, (whether pictures or brochures) are good tips to present information in this section. If possible the pricing policy and details can also be included here for the reader’s reference.

If applicable, point out that the product is passed through a control system of relevant quality control organization at national or regional levels. For example, state that the seed quality is certified by the national quality control service, for example, Tanzania Official Seed Certification Institute (TOSCI) for an enterprise operating in Tanzania.
8.2.3 Market analysis including competitors and plan to market the products or services

This section gives an idea of the potential market. Those who will be buying seeds and their different locations are presented here. Their characteristics in terms of average acreage, individual or in farmer associations or group farmers are also documented. The market analysis should target farmers in remote areas because they are hardly prioritized. The needs of the consumers should be highlighted including why and how, those needs have not made their way into the market. The amount they can purchase for each growing season should be estimated, as the quantification of market demand is very important.

As it is unlikely that a seed enterprise will operate alone in a region, it is important to know the potential competitors, to better place the seed at the market. Their production level, location and target market should be well known. This will enable to tailor a message to the customers indicating how your products are developed to specifically meet their need.

The biggest challenge is to market seeds and successfully deliver related services. Strategies to effectively reach the end-users of seeds is the core aspect to present here. It is advised to initiate some studies to explore consumer needs. The type of advertisement and awareness creation activities to expand market reach must be highlighted in this section. The kind of presentation of the products (packaging and pack size) that make them more visible, attractive and competitive on the market also needs to be presented here. It is also important to highlight key support services the customers can benefit while using your product.

8.2.4 Description of human resources, organization and management issues

The competencies that the seed enterprise involves should be presented in this section. The organizational structure and the process through which the product or service delivery is conducted are also presented. If applicable, showing the organizational chart is a good illustration.

8.2.5 Financial resources and cash flow statement

In this section, we present financial sources and their use or distribution based on different areas of expenses for the enterprise: from inputs through production, to sale in the market. The cash situation is presented for a certain time period, be it, a month, a quarter or a full seed growing season.

8.2.6 Business model

It is important for the enterprise to clearly specify, which design will help generate revenue and make profits from various operations. For example, the enterprise will have to decide whether it will handle all seed activities or focus on parts of activities leaving room for others to intervene through partnerships and contractual agreements. For example, the seed enterprise might decide to leave the promotion and marketing component of the business to specialized company or organization.

Figure 9. Key elements of a seed business plan.
8.3 A seed business plan template

8.3.1 Business plan structure
A seed business plan can be structured as follows:

1. Title page
2. Executive summary
3. Description of the unit/enterprise and vision statement
4. Description of products and/or services
5. Market analysis and marketing of products/services
6. Human resources, organization and management of unit/enterprise
7. Financial resources

8.3.2 Filling each section of the business plan
Filling each section consists of finding answers to the questions under each section:

(i) Title page
Seed enterprise name
Physical address
Phone number
Email address

Note: Include also brand name, enterprise motto (if any), and branch addresses

(ii) Executive summary
What can be said in terms of snapshot of the seed enterprise, including the goals? What are the key points to derive from different sections of the seed business plan?

(iii) Description of the unit/enterprise and vision statement
What is important to be known about the seed enterprise? Who are the people/professionals involved? What is the geographic representation in the country or region? What people used to say to praise the seed enterprise? What is the vision of the seed enterprise? What are the objectives of the seed enterprise?

(iv) Description of products or services to offer and what makes them unique
What are the different seed grades offered? What are their genetic and agronomic characteristics? What kind of illustration can I use for better visualization? What pricing details are relevant to include here? What major quality control agency to mention as quality assurance to gain the trust of end-users?

(v) Market analysis including competitors and plan to market the product or service
Who are the current and potential buyers of our seed? Where are they located? Do we have different market segments? If yes, what are their characteristics in terms of: average acreage, individual/group/associations of farmers, and product preference? How best can we reach farmers in remote areas? Overall, how big is the market, or how much can we market in total? Who are our competitors and where are they located? Do we target the same market segment?
What strategies do we use to effectively reach the end-users of seed? Do we need to investigate the consumer needs? What type of advertisement and awareness creation activities will effectively reach more end-users? How do we better present our products/services to remain visible and competitive on the market? What key support services the customers can benefit?

(vi) Description of human resources, organization and management issues

How is the seed enterprise organized? Through which process the product or services are delivered? Are we doing everything ourselves?

(vii) Financial resources and cash flow statement

What are our funding sources? How much do we need as loan and what are the existing affordable options? How much do we allocate for each areas of expenses? How does the cash flow look like for a seed growing season?

9. Conclusion

Seeds are major agricultural inputs and are the most valuable asset for smallholder farmers. The small proportion of smallholder farmers who are using seeds of improved varieties, is a strong argument that the seed market is big, but poorly utilized. It is common that most seed companies complain about seed market but make little efforts to create and expand their market reach. This training manual provides tips and tools to run and expand seed business over time.

Selected literature


http://oar.icrisat.org/420/1/CO_200803.pdf

10. Appendixes

Appendix 1. Tool for seed production record-keeping

<table>
<thead>
<tr>
<th>Location (Region / district / village)</th>
<th>Seed producer</th>
<th>Varieties</th>
<th>Amount Basic seed supplied</th>
<th>Planting date</th>
<th>Fertilizer used</th>
<th>Fertilizer dose</th>
<th>Pesticide used</th>
<th>Pesticide dose</th>
<th>Pests &amp; diseases</th>
<th>Inspection dates</th>
<th>Harvest date</th>
<th>Yield Verified by</th>
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</thead>
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</tbody>
</table>

Appendix 2. Tool for seed sale records keeping

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Location (Regions / District / Village)</th>
<th>Distributor (agro-dealers, seed enterprise, others)</th>
<th>Type of clients</th>
<th>Clients’ location</th>
<th>Amount sold</th>
<th>Price per Kg</th>
<th>Period of sales</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

Appendix 3. Tool to rate contract seed farmer

**Rating scale:** 81-100 Excellent, 61-80 Good, 44-60 Average, Below 44 Poor

**Categories:** A for Excellent, B for Good, C for Average, D for poor

<table>
<thead>
<tr>
<th>Contract Farmers Rate over 25</th>
<th>Total rate</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respect of production standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield achieved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production of amount contracted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attendance of seed company meetings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Consider getting rid of D and closely monitor C

Appendix 4. Seed label information

- Enterprise details (enterprise name, logo and address):
- Crop (e.g., groundnut):
- Class of Seed (e.g., QDS):
- Variety Name (include well-known variety name):
- Treatment Used (list if any):
- Lot number (enterprise assigned production and processing lot number):
- Seed Grade (e.g., small- or large-seeded):
- Purity (%):
- Germination Rate (%):
- Certified by (name of official certification agency):
### Appendix 5. Tool to quantify seed demand in operation area (district, region, country)

<table>
<thead>
<tr>
<th>Clients’ name per category</th>
<th>Region/district</th>
<th>Villages</th>
<th>Crop varieties</th>
<th>Security stock for unforeseen</th>
<th>Total amount estimate (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clients as farmers’ groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Clients as individual farmers</td>
<td></td>
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<tr>
<td>Clients as large farmers</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Clients as Agro-dealers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clients as seed companies</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Clients as NGOs/Development Organizations/Aid agencies/Projects</td>
<td></td>
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<td></td>
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<tr>
<td>Clients as government institutions (central and local government)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Clients as exporters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clients as foreign buyers</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Appendix 6. Groundnut seed quality standards

Appendix 6.1. Field standards for groundnut seed production in Eastern and Southern Africa

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre-basic</th>
<th>Basic</th>
<th>Certified</th>
<th>Quality declared seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation</td>
<td>10</td>
<td>10</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Maximum off-type (%)</td>
<td>0.1</td>
<td>0.1</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Minimum number of inspections</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Maximum number of plants infected with Ralstonia solanacearum (bacterial wilt)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Maximum number of plants infected with rosette disease</td>
<td>1/1000 plants</td>
<td>1/1000 plants</td>
<td>5/1000 plants</td>
<td></td>
</tr>
</tbody>
</table>

Appendix 6.2. Laboratory standards for seed lot of groundnut

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre-basic</th>
<th>Basic</th>
<th>Certified</th>
<th>Quality declared seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure seed (%)</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td>Maximum inert matter (%)</td>
<td>1.95</td>
<td>1.95</td>
<td>1.95</td>
<td></td>
</tr>
<tr>
<td>Minimum other seeds (%)</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Minimum germination (%)</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Maximum moisture content (%)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Weed seed maximum in 1kg</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Appendix 7. Business model canvas: overview of the business plan
## Appendix 8. Seed quality self-assessment tool

<table>
<thead>
<tr>
<th>SEED QUALITY MANAGEMENT ASSESSMENT TOOL</th>
<th>SPECIFICATIONS / STANDARDS</th>
<th>Implementation period</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Soybeans</th>
<th>Groundnuts</th>
<th>Common beans</th>
<th>Glycine max</th>
<th>Arachis hypogaea</th>
<th>Phaseolus vulgaris</th>
</tr>
</thead>
</table>

### Seed source
- Get your foundation seed from a certified seed agent in packaging that bears the label “XX?” or get it from a research center / ASA
- Don’t recycle your seed from your crop for more than 3 years, but instead replace what you have with foundation seed

### Land choice
- **- Soil type**
  - Choose fields with soils with good moisture filtration properties, or in other words, soils that drain well
  - May to July

### Land history
- **- For foundation seed**
  - No soya planted on the same field in the past 2 years
  - No beans planted on the same field in the past 2 years

- **- For certified seed**
  - No soya planted on the same field in the past 1 year
  - No beans planted on the same field in the past 2 years

### Land isolation
- **- For foundation seed**
  - At least 10 m from a neighbor’s field
  - At least 50 m from a neighbor’s field
  - May to July

- **- For certified seed**
  - At least 5 m from a neighbor’s field
  - At least 25 m from a neighbor’s field
  - May to July

### Land preparation
- **- Ploughing**
  - Good tilth resulting in well-aerated soils that allow movement of water
  - June to September

- **- Harrowing**
  - Good tilth resulting in well-aerated soils that allow movement of water
  - June to September

- **- Ridge / row markings**
  - Rows
  - Ridges / beds
  - Rows
  - October to December

### Moisture requirement
- At least 40 mm of rainfall distributed over 3 months
  - November/December to January/February

### Planting
- **- Inter-row spacing**
  - 50 - 60 cm apart
  - 75 cm apart
  - 50 cm apart
  - October to December

- **- Intra-row spacing**
  - 5 cm between stations
  - 7.5 cm between stations
  - 10 cm between stations
  - October to December

- **- Seeds per station**
  - Only 1 seed per station
  - November to January

- **- Seeding rate**
  - 50 to 80 kg per hectare
  - November to January

### Fertilization
- **- Basal application**
  - Phosphate at time of planting, although not critical
  - 30kg/ha P2O5, 25kgN/ha
  - November to January

- **- Top dressing**
  - None
  - Foliar fertilizers and gypsum (for groundnut)
  - December to January
<table>
<thead>
<tr>
<th><strong>- Inoculation</strong></th>
<th>50mg Rhizobium per 25kg seed prior to planting</th>
<th>Not necessary</th>
<th>October to December</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Germination rate</strong></td>
<td>At least 75% at time of emergence, indicating quality</td>
<td>At least 80% at time of emergence, indicating quality</td>
<td>November to January</td>
</tr>
<tr>
<td><strong>Weeding</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Manually</td>
<td>Keep fields free from weeds at all times</td>
<td></td>
<td>November to April</td>
</tr>
<tr>
<td>- Using herbicide</td>
<td>4liter Roundup® and/or 1liter Harness® pre- and post-emergence of seedlings</td>
<td></td>
<td>October to January</td>
</tr>
<tr>
<td><strong>Rogueing</strong></td>
<td>Continuously remove any off-type plants, i.e., plants which do not resemble others in the field and are likely of a different variety</td>
<td></td>
<td>November to April</td>
</tr>
<tr>
<td><strong>Pest and disease management</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Scouting</td>
<td>4 inspections in the field only</td>
<td>4 field- and 2 post-harvest-inspections</td>
<td>5 field inspections</td>
</tr>
<tr>
<td>- Control measures</td>
<td>Either rogue / remove affected individual plants or apply chemicals as indicated in their instructions</td>
<td></td>
<td>September to May</td>
</tr>
<tr>
<td><strong>Harvesting</strong></td>
<td>Uproot and stack in heaps, all the while avoiding shattering</td>
<td>Build 'Mandela' stack avoiding exposure of pods to sunlight</td>
<td>Uproot and stack in heaps, all the while avoiding shattering</td>
</tr>
<tr>
<td></td>
<td>Harvest and stack crop of seed separately from that which is to be consumed or sold as grain</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Moisture content</strong></td>
<td>Maximum of 13% indicating quality</td>
<td>Maximum of 10% indicating quality</td>
<td>Maximum of 13% indicating quality</td>
</tr>
<tr>
<td><strong>Processing</strong></td>
<td>Thresh, once pods are dry and do not beat hard with sticks</td>
<td>Shell by hand or use specialized machinery</td>
<td>Thresh, once pods are dry and do not beat hard with sticks</td>
</tr>
<tr>
<td></td>
<td>Remove all foreign matter including stones, grass and dirt</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grading</strong></td>
<td>Remove off-colored and deformed grains keeping instead those uniform in size</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Purity</strong></td>
<td>Seed should be as pure and uniform as possible, at least XX%, thereby indicating quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bagging</strong></td>
<td>Put in clean, preferably new / unused poly or gunny bags of 50kg capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Labelling</strong></td>
<td>Place duplicate labels on the inside and outside of each bag giving the name of the variety, year of production and unique lot number if possible</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seed treatment</strong></td>
<td>Dress seed with recommended pesticides, for e.g., Actellic®, and/or fungicides, for e.g., Thiram, according to instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>Store on pallets / shelves (not on the bare floor) in a cool, dry, well-ventilated and rodent free room (place rat / mouse traps and/or rodent poison if necessary)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transport to markets</strong></td>
<td>Transport on a dry, clean, oil-free and well tarp lined surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quality control</strong></td>
<td>Arrange for field and laboratory inspection of your seed by seed services unit of the Department of Agricultural Research Services well in advance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 9. Some technical aspects of groundnut seed production

Climate conditions

Groundnut tolerates a temperature range between 24-35°C, an evenly distributed rainfall range between 450-1200 mm, an altitude below 1500 m. Early maturing small-seeded varieties need 300-500 mm; medium to late maturing large-seeded varieties need 1000-1200 mm of rainfall.

Soil selection and plot preparation

Heavy soils are not good for groundnut. Well drained sandy, sandy loam, loamy sandy soils that facilitate pegging and rooting are suitable. Soil acidity below pH 5.5 will require additional precautions.

Field isolation

As the crop is close to 100% self-pollinated, 3-5m distance between plots holding different varieties is good for certified seed production.

Seed selection

Use pure seed variety obtained from reliable seed sources, e.g., registered seed companies, research or extension services. The seed variety should fit the environmental conditions (pests, diseases, rainfall, and market preferences). Plot should be made ready before rainfall establishment or planting time.

Sowing and planting density

Plant during the time when moisture is stable in the soil, at about 5-6cm depth. The spacing is 10-20cm between plants on the same row and 30-50cm between plants in 2 rows. In Uganda the recommended planting densities are: for semi-erect types: 45 X 10-15 cm e.g., Serenut1R, Serenut 2, Serenuts 7T, Serenut 8R; for bunch types: 45cm X 7.5-10 cm e.g., Serenut 4T, 5R, 6T.

In case of high pest occurrence, seed must be dressed prior to planting using relevant pesticides, mostly fungicides (e.g., Thiram as a dust at 120 g /100 kg of seed) to protect both seeds and seedlings.

Fertilizer application

Being a legume, groundnut is not dependent on direct nitrogen fertilization. However, it requires adequate levels of phosphorus and potassium for normal growth and development. Calcium in particular is very important for seed development and is regarded as an essential element in groundnut production. For phosphate deficiency, single super phosphate (100–125kg/ha) or triple super phosphate (80–90kg/ha) should be incorporated into the soil before planting. To correct calcium levels in the soil, gypsum (200–500kg/ha) is recommended.

Crop rotation

Groundnut mono-cropping on the same land over years increases the build-up of pest and diseases. Avoid plant of the same botanical family, fabaceae instead, rotation with cereal is advised (maize, sorghum, and millets).

Weed control

Weed 2-3 times. Groundnut is a weak competitor with weeds for moisture, nutrition, light and space.

The presence of weed seed in produced groundnut seed is a disqualifying factor.
Rogueing/off-type check

Plants of other varieties should be checked and manually removed. Rogueing can intervene at any of these stages: seedling, early growth, flowering, maturity, and harvest. Rogueing criteria include: weak, giant, distorted, variegated, diseased, and out of the row alignment seedlings, variants and not conforming to flower morphology, branching pattern, growth habit, and peg morphology. Any plant with vegetative characteristics not conforming to the variety under seed multiplication should be removed and destroyed.

Pests and diseases

The field pests and diseases often associated with groundnuts include, the soil-borne arthropods, termites, millipedes and white grubs that cause damage to groundnut roots, pegs and pods. Foliar pests include aphids, grasshoppers, crickets and leaf-eating caterpillars. Diseases attacking their groundnut crops of which ‘premature death’ are root/stem rots, leaf spots, and rosette. They impact not only the crop productivity but also the quality of seed produced: poor pod filling, small seed size, seed damage, shrivelled seed, and low germination.

Handpicking, rogueing, spray, seed dressing and use of tolerant varieties are ways to control them.

Harvest and postharvest

Premature and over mature harvesting may have economic consequences. It is the reason why the crop can be harvested when about 70% of the pods are mature. Leaves turning yellow, kernel separated from the shell, dark inner marking of pods are some characteristics of ready to harvest groundnut. Uprooting few plants, helps to confirm maturity and decide on harvesting. Harvested groundnut are often dried at ambient temperature in the field or in dedicated spaces. Whatever drying option, reducing the water moisture below 15% is important to reduce postharvest loss.

Packaging and seed storage

Seeds are packed in well aerated bags and tagged. The storage should be in pod and not shelled. Storage temperature (ambient temperature) and relative humidity (60%-70%) are strong drivers of postharvest viability loss.

Monitoring and inspection

While nucleus and breeder seeds are not subjected to inspection, it is mandatory that foundation, registered, certified seeds and to some extent quality declared seed undergo 2-3 seed inspector checks.

Seed testing

The following tests are conducted: (1) varietal purity, (2) other varieties, crop seed and weed, (3) inert material, (4) germination, and (5) moisture content.
ICRISAT works in agricultural research for development across the drylands of Africa and Asia, making farming profitable for smallholder farmers while reducing malnutrition and environmental degradation. We work across the entire value chain from developing new varieties to agribusiness and linking farmers to markets.

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We believe all people have a right to nutritious food and a better livelihood.

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