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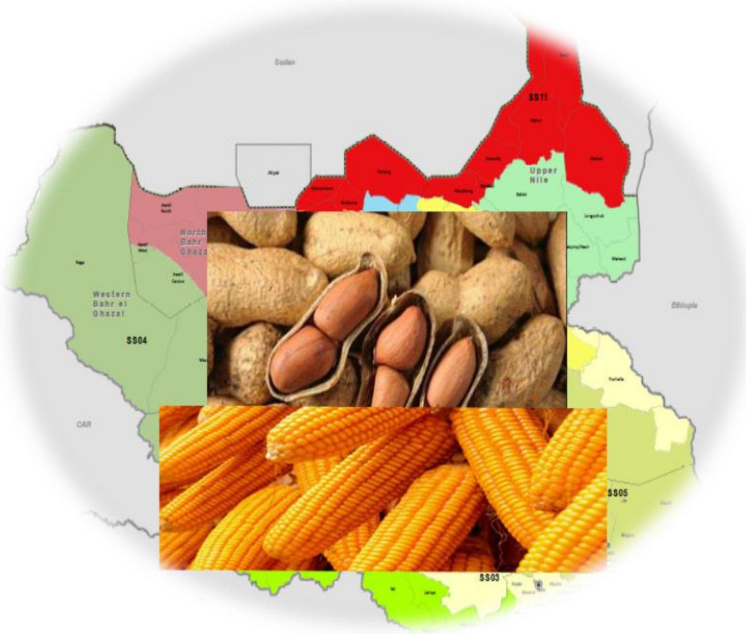
Good Quality Seed Production Guide

for

Smallholder Farmers in South Sudan



A Field Guide for Extension Workers

SORUDEV
South Sudan Rural Development Programme

Contents

Measurements used

1 hectare = 2.47105 acres
1 Feddan = 0.42 hectares, which is equivalent to 1.038 acres
1 Malwa = 3.5kg
1 Mug = 0.5 Kg
1 Shawal = 50kg
1 Kg = 1000g

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Illustrations by

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Foreword

Preface

Abbreviations

Abbreviations	Meaning
^0C	Degree Celsius
EUD	European Union Delegation
FAO	Food and Agriculture Organization
Fews net	Famine Early Warning Systems Network
HESSREP	Harmonised East African Seed Standards, Regulations and Procedures
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute for Tropical Agriculture
ISTA	International Seed Testing Association
DNA	Deoxyribonucleic acid
KM	Kilometres
REC	Africa’s Regional Economic Communities
Mm	Millimetres
GMO	Genetically Modified
MT	Metric Ton
N P K	Nitrogen Phosphorus Potassium
Pp	Plant Population
NGO	Non-Governmental Organizations
MAFS	Ministry of Agriculture and Food Security
OPV	Open Pollinated Varieties
UNIDO	United nation Industrial Development Organization
WVI	World Vision International

Introduction

South Sudan is located between coordinates 6.8770° N, 31.3070° E, East of Africa. The population is about 13 million comprised of different ethnic groups. The vast majority of the people live in the rural areas. The common farming system is in two broad categories: 1). Pastoralist and 2). Agro-pastoralist. The country is zoned into seven agro-ecological zones most of which are conducive for cultivating a variety of crops and having vegetation that support pastoral activities. Pastoralist communities refer to the population whose main livelihood activities is based mainly on rearing livestock. The agro pastoralist communities combines the rearing of livestock with the farming of major stable crops for their livelihoods.

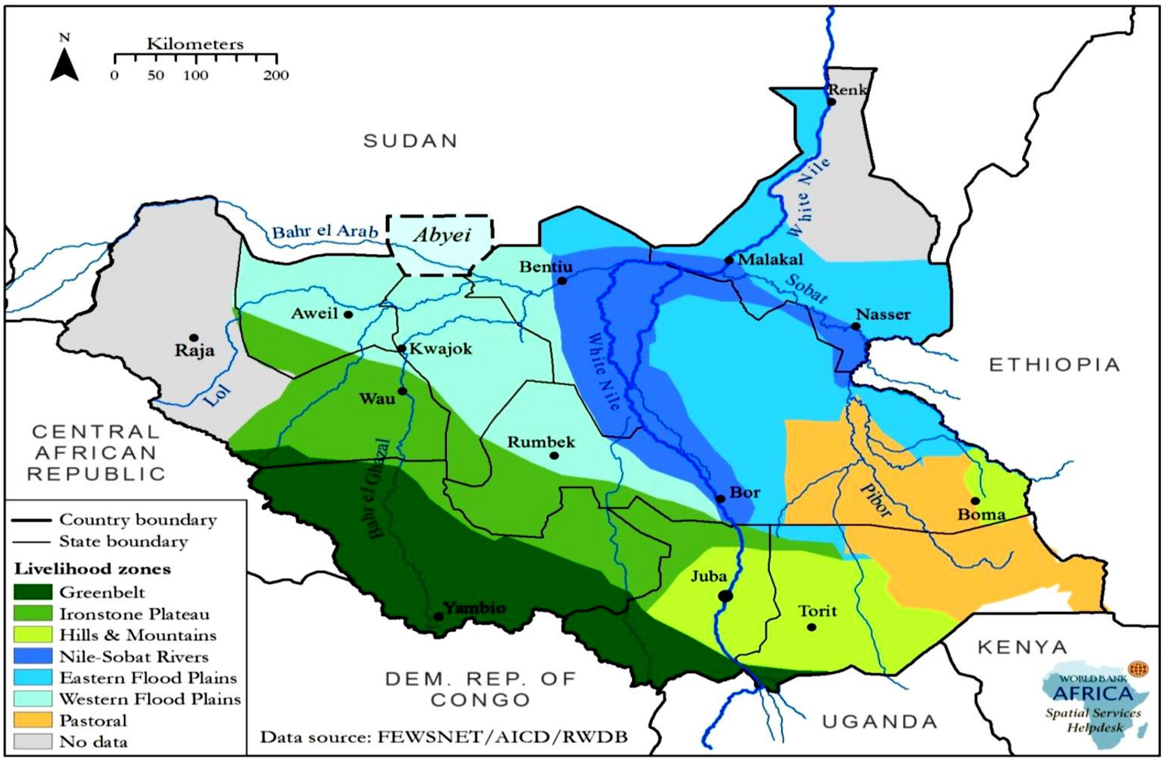
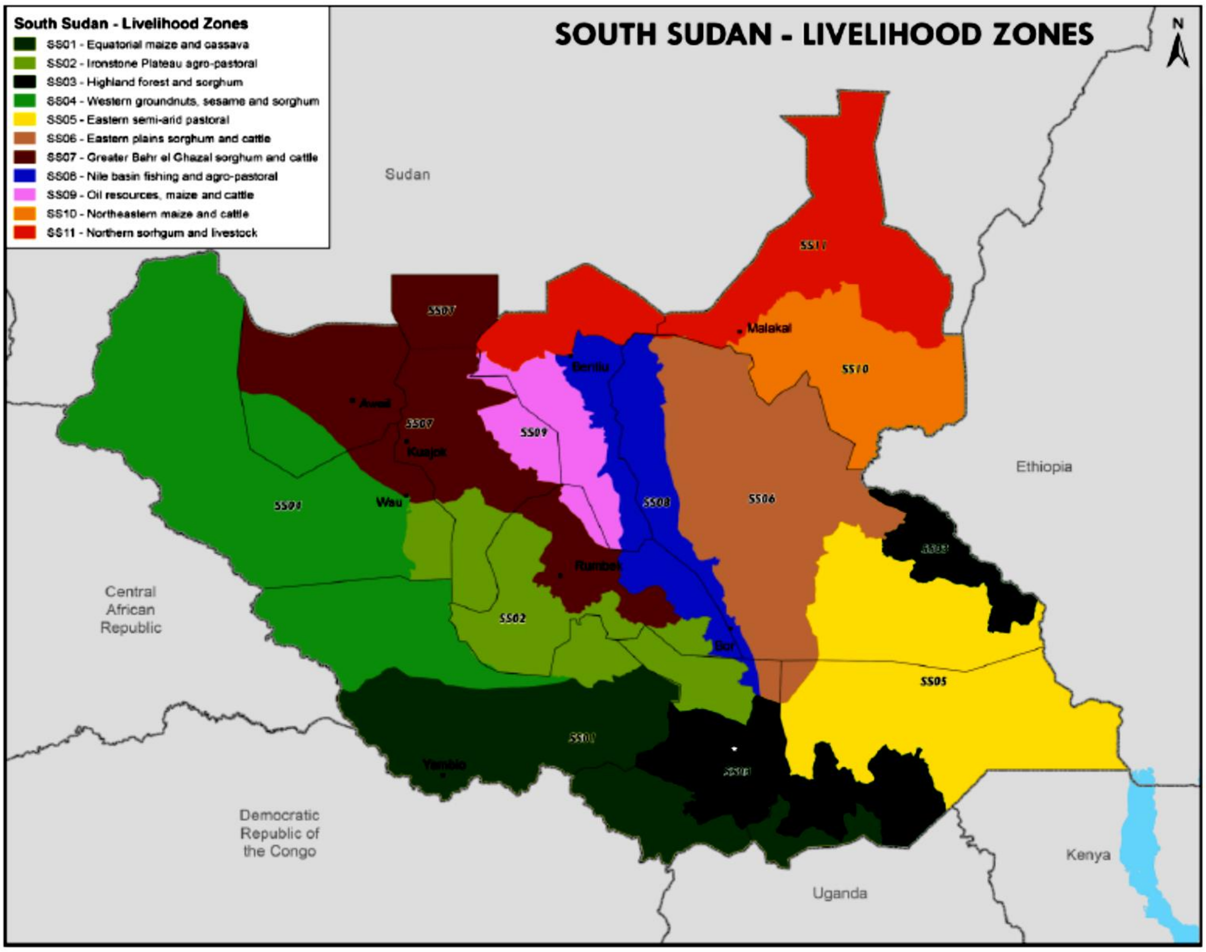


Table 1: Agro ecological zones map of South Sudan. Source FEWS NET accessed 2018

The agro ecological zones and the old states which constitute them are: 1) Greenbelt (Western Bahr el Ghazal, Western, Central and Eastern Equatoria); 2) Ironstone Plateau (Northern and Western Bahr el Ghazal; Warrap; Lakes; Western, Central and Eastern Equatoria); 3) Hills and Mountains (Central and Eastern Equatoria; Jonglei); 4) Arid/Pastoral (Jonglei; Eastern Equatoria); 5) Nile and Sobat Rivers (Jonglei; Unity; Upper Nile); 6) Western Flood Plains (Northern Bahr el Ghazal; Lakes; Warrap); and 7) Eastern Flood Plains (Jonglei; Upper Nile).



Most farming activities are at subsistence and small holding level. Most are rain fed with approximately 78% of households reliant upon crop farming and animal husbandry as their main source of livelihood. Out of the total land mass of 644,329 km^2, more than half is estimated to be arable.

The annual rainfall range for South Sudan is from 500 mm to 2,000 mm. The rainfall pattern along the agro-ecological zones influences the crop grown and the timing of operation of different agronomic practices undertaken by farmers. Below is a typical seasonal calendar for cropping operations across the different agro-ecological zones.

Served by many tributaries and host of major rivers, the White Nile River is the main source of fresh water and important source of water for the Sudd Wet Land. Along with many other smaller streams and rivers they empty into the flood plains which are a major source of fishing and livelihood for coastal communities.

Currently, less than 10% of available land is under cultivation, therefore the potential for investment and return on investing in farming for all South Sudanese (and investors) is massive under the varied agro ecological zones and rainfall pattern. Assessments shows that the current scale of cultivation is low with limited area cultivation, productivity level of major crops per hectare is still very low and this is attributed in part to inadequate farming knowledge, low up take up of technology, inadequate farm inputs such as farm machineries/tools and lack of access to good quality seeds among others.

Specific to Seeds, in the current practice, there is no clear distinction between seeds and grains; and there is an absence of a formal seed system, the traditional seed system which are largely uncoordinated are the most popular.

There is a collective understanding that seeds are perhaps the most important input of any crop production system and that the seed stock grown by farmers in South Sudan are lacking in quality and not necessarily the most improved. Some of the seeds are either wild traditional varieties (heirloom) or very old open variety stocks which were released some 20 years back. However as these varieties have been planted continually over many season and over a long period of time, the genetic characteristics of the seeds could be eroded. Seed therefore is among the first consideration towards ensuring food security for the conflict affected farmers and rural population of South Sudan.

This guide on certified seed production techniques therefore provides simple explanation on the basic techniques and to help in deepening the understanding needed for producing good and certified quality seeds for smallholder farmers in general, and for the use of front line crop extensionist in South Sudan.

Seasonal Calendar

Below is a typical seasonal calendar for cropping operations across the different agro ecological zones in South Sudan

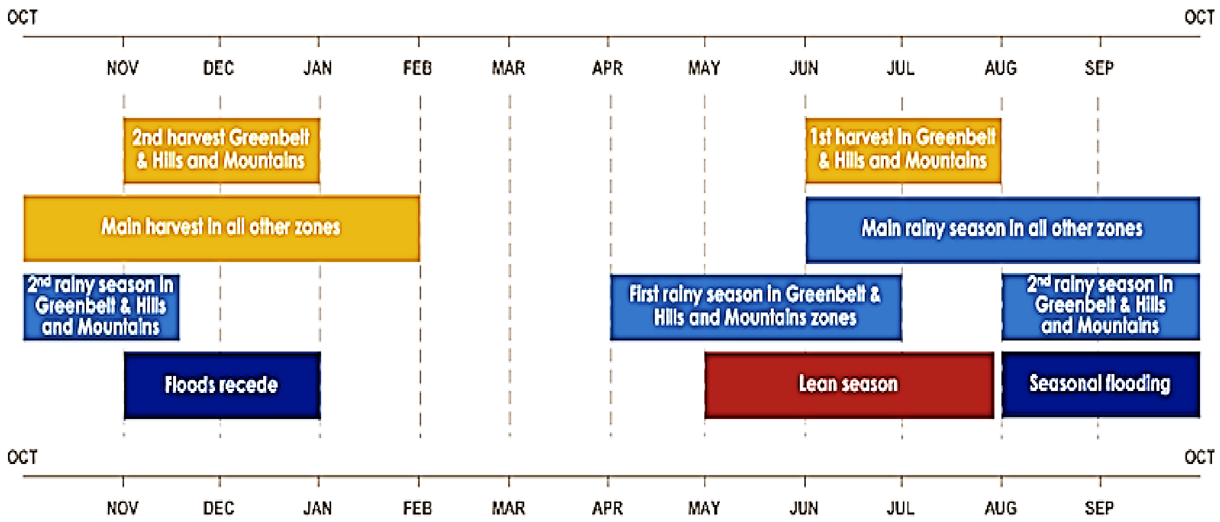


Table 2: South Sudan typical seasonal calendar across agro ecological zone (Source: Fewsnet accessed July 2018)

Cropping in most part of the South Sudan takes place twice determined by the arrival of the rains. In a typical season (which is the main cropping season for sowing of cereals) begins in June at the onset of rains. Dry season farming mostly for vegetables around water bodies begins in October through February using small irrigation systems and tools such as watering cans and in some cases the Treadle Pump.

Government policies on seed production in South Sudan

South Sudan land mass of 644,329 km^2 is massive. The country is bordered by six countries with very close affinity and cultural linkages. The countries bordering the Republic of South Sudan are Sudan, Ethiopia, Kenya, Uganda, Democratic Republic of Congo and Central African Republic. The borders are long, largely unmanned which allows free movement of people, as a result it is not unusual to find different varieties of seeds indigenous to a group of people moving freely from the different countries into South Sudan. All of these add to the confusion faced by farmers in selecting appropriate seeds and accessing the right type, right quantity and the desired quality of seeds. Development partners (NGOs, International organizations) working in seed production also assist in procuring and moving seeds within the country or from across the border for cultivation by smallholder farmers.

As most of the seeds sown by farmers in South Sudan are from traditional sources the imported seeds from neighbouring East African countries such as Uganda, Ethiopia, Kenya and Sudan augments the seed stock. The majority of the seeds imported though from the same region but may not be entirely local to the specific agro-ecologies of South Sudan. Notwithstanding, some of the imported seeds have been used over time and are now trusted by farmers. For many of the seeds imported there are complaints of loss of viability, low vigour to outright failure by the time they reach the farmers.

Seed production, seed certification and formal seed marketing at scale are only just beginning in South Sudan. Though plant breeding and adaptive research works are ongoing by the Ministry of Agriculture and a few NGOs such as World Vision and AGRA, the Agricultural research institutes/centres including the National Research Institute are weak due to absence of a budget, lack of the required manpower, low motivation, derelict physical infrastructure and the general prevailing insecurity across the country. In addition to this, there are limited number of reputable private seed producers and companies. As a result, many of the seed stocks and references utilised are from the old Sudan and from the neighbouring countries.

To address these issues, the Republic of South Sudan is in the process of approving a National Seed Bill. The draft produced in 2012, revised in 2013 is currently awaiting approval. The Bill integrates the Harmonised East African Seed Standards, Regulations and Procedures (HESSREP). HESSREP is part of the Legal and regulatory reform, it's a significant component of regional harmonization and the rules and standards created by Africa's Regional Economic Communities (REC) constitute a comprehensive framework for development of the seed sector. When in operation, the bill will lay the laws and regulations for governing seed systems in the country. The department of Research in the Federal Ministry of Agriculture and Food Security is responsible for regulating seed production in the country.

Seed Inspectors and supervisors

Seed inspectors are usually from government institutions like the Ministry of Agriculture and Food Security, Research institutes and/or Seed Certification boards. Increasingly, the private seeds producing companies have trained and equipped their seed inspectors to work with and monitor seed producer farmers. On some occasions these inspectors are extension staff, with certified specialisation as Agronomist or Crop Production, being trained in seed handling and inspection. They are expected to work with the farmers through the seed production stages: pre-planting, sowing, flowering, pre-harvest, harvesting and post-harvest. In some cases they are mainly involved at receiving centres where they accept or reject seed consignments brought in by farmers. Essentially, seed inspectors work under the supervision of Seed Supervisors and their role as seed inspectors are in compliance to all agreed seed production protocols. The report on crop growth, progress and the records of data on field production shall meet the quality specifications of both company and government certification agency.

There are a number of government infrastructure supporting research in the country. Under the Ministry of Agriculture and Food Security are:

1. Yei Basic Research Centre and Seed Laboratory
2. Palotaka Basic Seed Centre and seed Processor
3. Halima Research Station and Seed Laboratory
4. Wau Soil Laboratory

The centres when full rehabilitated along with the research activities in the University of Juba are designated centres for research and training for seed inspectors and supervisors.

The 'Quality Declared Seed' system

The process of certifying seeds may be laborious and hard to achieve in situations of conflict and fragility. Often these situation presents moments of diminished infrastructure and limited human expertise yet the vast majority of people caught in the conflict zones or emerging from the conflict are farmers obtaining most of their sustenance and livelihood from farming and as such demand seeds for planting. To improve the quality of seed being offered for sale in countries where human and physical resources for quality control are limited, FAO has introduced the 'Quality Declared Seed' system which makes use of resources already available in seed production organizations. The system is designed to provide quality control during seed production which is less demanding on government resources than seed certification but is adequate to provide good quality seed both within countries and in international trade. Part I of Quality declared seed outlines the general guidelines applicable to all crop species. Part II deals with guidelines on individual crop species by category: cereals, food legumes oil crops, forage crops (both grasses and legumes), industrial crops and vegetable crops. Annex IV presents a guiding note that shows World Vision experience in South Sudan with relevant examples in the East African Sub region.

Production for Seeds versus Production for Grains

A grain is a small edible fruit, usually hard on the outside, harvested from grassy crops. Grains basically grow in a cluster on top of a mature grass plant such as maize, corn, wheat, oats, rice and barley. Because grains are generally grown by many farmers at varying scales, they are considered staple crops and they are the number one energy providers worldwide. It is important to understand that nearly all plants possess a means of regeneration. They all have propagation means such as seeds and other planting materials.

In this guide, the word seed is used to describe a whole grain of crops which has the ability to grow into a full plant naturally or as nurtured by the grower. It is important also to note that though many seeds, grains or nuts will germinate when planted, but they may not necessarily grow into what a farmer wants or that they may not necessarily lead to good yield.

Grains for consumption	Seeds for planting
A grain is a fusion of the seed coat and the fruit	A seed is an ovule containing an embryo
Grains are harvested for food	Seeds are planted to grow plants
Grains provide food from the fruit part	Seeds mainly provide food from embryo parts
A grain can still be eaten when the embryo is dead	A seed will not germinate if planted when the embryo is dead

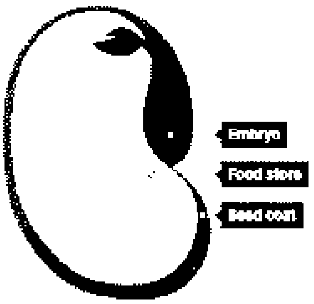
For example most of the imported popcorn grains sold in our local supermarkets will not germinate if planted because they have been exposed to conditions that make their embryo complete dormant or completely dead. Yet we make lovely fluffy pop corns from them. In contrast many of the vegetable seeds marketed are in vacuum sealed packets to properly preserve them and they could be sown to produce a crop.

Other Planting Materials

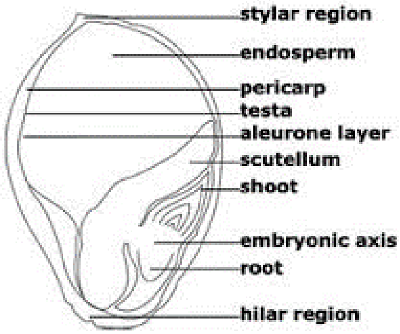
As mentioned above, a seed is usually planted to produce another plant. However, seeds are not the only materials from which other plants grow. Examples of other planting materials produced through asexual propagation method are from growing parts of an already growing plant or crop. These are called vegetative parts. Example of vegetative parts are stem cuttings, vines, roots, stalks, leaves, buds, tubers, corms, rhizomes, bulbs and many more.

Pollination and Fertilization

A seed is defined as an embryonic plant covered in a seed coat, often containing some food. It is formed from the ripened ovule of plants after fertilization. Seed formation begins with the growth of flowers and then followed by pollination in seed plants. The embryo grows from the zygote while the seed coat grows from the ovule rind. See diagram showing parts of a dissected seed below



Cowpea Seed

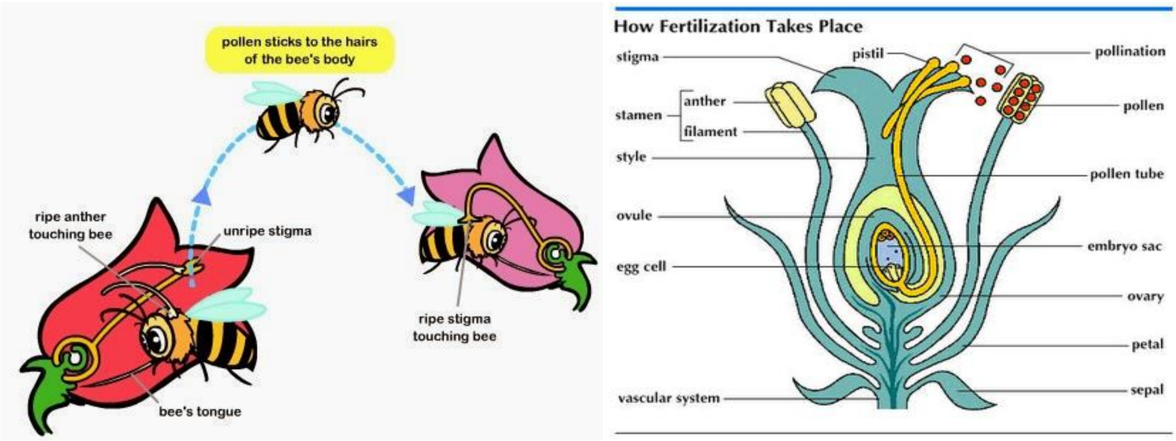


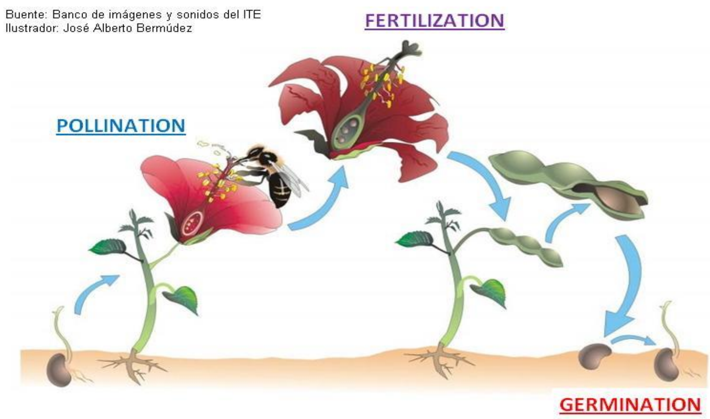
Sorghum Seed

Pollination and fertilization are two events in the process of sexual reproduction in plants. Pollination is followed by fertilization. The flower is the sexual reproduction organ in plants and consists of both male and female reproduction organs of the plant. The male parts of the flower are called the stamens, and it consists of anthers, held up by filaments. Pollen grains, which are the male sex cells, are produced in the anther. Female sex cells are produced in ovaries, which are contained in the ovule. Stigma collects the pollen grains for the fertilization.

Brightly coloured petals and nectar attract insects to the flower in order to enhance the pollination. The main difference between pollination and fertilization is that pollination is the deposition of pollen grains from the anther to a stigma of a flower whereas fertilization is the fusion of the haploid gametes, forming a diploid zygote. In breeding, fertilization could be assisted or carried out by scientists through a process known as mastication.

Diagram Showing Pollination and Fertilization





In their natural setting the traditional or wild varieties are pollinated through natural agents such as wind or insects. From the pollination activities male and female part of the plants cross, fertilised and produce fruits or cobs from where we derive seeds. In nature it is not all seeds that are collected and planted by humans, the natural cycle encourages fruits to drop when they are mature (this is very evident when wind blows and tree branches sway from one end to the other), the fallen fruits rot, and over time the seeds in them germinates when the condition are right such as when there is water (moisture) and the right amount of heat. In many parts of South Sudan, this is still the case with mangoes for instance.

Attribute of good quality certified seeds

Using good quality and certified seeds at all times is very important. In farming seeds are critical input to enhance production and productivity. Seeds are the first set of input required for crop farming. When good quality seeds are planted, chances are that yield will be higher. Evidence and experience from farmers have shown that planting good quality seeds has many advantages. These are:

- Good quality seeds can increase yield significantly and in some cases could double yield. If yield is increased significantly, there will be more food and farmers will make more money from selling surplus.
- Good quality seeds will reduce the amount of weeds on the farm.
- With good quality seeds farmer are more likely to have uniform type of seeds growing together which makes it easier for farmers to undertake other cultural practices such as thinning, weeding, fertilizer application, harvesting and many more.
- Good quality seeds also protect farmer from disease crops. This is possible because some diseases are introduced by seeds that are already infected. Planting such seeds exposes farmers to introduce seed-borne diseases.
- Planting good quality seeds makes economic sense because the seeds will germinate and have the vigour to succeed. It is a waste of time and a waste of valuable resources including waste of family labour for farmers to clear land, prepare it and then sown seeds that have very low germination percentage or seeds that would not germinate at all.

Common Sources of Seeds

The common practice among subsistence and smallholder farmers in South Sudan is to access seeds through the following ways:

1. Own seeds. This is usually from the seeds they store from their harvest.
2. Gift from other farmers and relatives (including trade by barter).
3. Seed fairs (a recollection system)
4. Purchase from agro dealers and open markets (especially for vegetable seeds)
5. Zakat (common among the Muslims as an Islamic obligation to the poor and needy)

Successful crop farming starts with sowing good quality seeds.

Type of Seeds

Generally there are three types of seeds.

Breeder Seeds

These are new variety of seeds which are the result of breeder's effort in crossing varieties with specific and desirable qualities. Breeder seeds are carefully produced by highly skilled scientists in a controlled environment usually in research institutions, education centres or specialised seed companies. As a result, breeder seeds have the highest genetic purity level (100%). Breeder seeds are expected to be pure and are of the description of the breeder in terms of character and identity. Every other related variety of a particular crop seeds should be traceable to the breeder seeds. Breeder seeds are usually registered as released by the Variety Released Committee, research institute or by a government approved breeding programme.

Foundation Seeds

Foundation seeds are the direct result obtained by growing breeder seeds. Foundations seeds are certified seeds often produced under the supervision and control of the breeder or releasing institution.

Certified seeds

Certified seeds are produced from the breeder and foundation seeds having followed a set of approved procedures (also called protocols) established by the releasing institutions and or government agencies responsible for seed release in the country. For seeds to be accepted as certified, they must maintain genetic purity and identity of the variety as described by the breeder.

Certified seeds are seeds that have been produced under control, using strict seed production protocols and supervised by seed inspectors. They are produced from Foundation seeds and should be very clean with high germination percentage and high vigour. These are the seeds mostly planted by large scale farmers and increasingly demanded by small holder farmers.

Types of Seed Varieties

There are also different seed varieties most of which are either from plants growing in the wild but identified through natural selection, and/or could be a product of the breeding in the lab, experimental fields, and research plots or on the farmer fields.

Seed varieties are categorised broadly as

- Land races
- Open Pollinated
- Hybrid
- F1 Hybrid
- Biologically Modified Seeds

Land races (traditional varieties):

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

Open Pollinated Seed Varieties:

These are varieties of seeds produced by controlled natural processes through pollinating agents such as winds, birds or insects. With open pollinated seeds, the natural processes are controlled to ensure that pollens from a specific male plant variety are deposited on a similar female plant variety through winds, birds and or insects without contamination. The only difference is that it occurs in a controlled environment on the field which are often isolated (read more about Isolation below).

In the wild there is no ways of controlling how many pollen types from a male plant lands on a female plant; though seasons could be clear but nature also have its own risks of either starting earlier or coming late in the year. Therefore the outcome of any cycle of fertilization is unknown and the products from such fertilization process cannot be predicted, thus making fertilisation sequence tricky.

Therefore, in open pollination, farmers and agriculturists control the cross-pollinating process so that two of the same varieties of plant are guided to cross through again wind, birds or insects.

The key aspect to ensure proper control and guide is to ensure isolation and to have the skill for selecting seeds with vigour and the desired characteristics desired by farmers. When this happens and it is successful, the result of the cross-pollination is that the plants are naturally mixed but very similar. The seeds originating from this guided process is called and marketed as Open Pollinated varieties or OP or OPVs.

Experts with the skill set working with farmers or on research farms have produced good seeds by proper isolation. There are OP plants that are high yielding; many are either tolerant or resistant to a set of pests and diseases.

The advantage of an OP seed is that it will produce the same type of plant of its parent, even if the plant gets pollinated by a different representative of the same variety. Yield are usually a lot higher than those of the wild varieties and, even more important to smallholder farmers, is that the OP seeds can be collected by farmers, processed, stored, planted, harvested and again planted over a relatively long period of between 3-5 years if the conditions are right and the seeds are well handled.

Hybrid seeds

Hybrid seeds are increasing in popularity across Africa and in the East African region. Unlike the Open pollinated, seeds are described as “hybrid” when a plant variety is developed through a specific and carefully controlled cross of two parent plants.

Usually, hybrids are produced by the cross pollination of male with the female parts of parents of the same species. The selected crop varieties could be inbred lines like the open pollinated.

In other words the difference between a "hybrid" seed from an open pollinated is that the pollination of the two plants from the same species are guided, directed and controlled to cross.

The yields from hybrid are much higher than the open pollinated types. Though hybrid requires a relatively higher input from farmers but hybrid seeds can be shared as farmers' seed or grains over a shorter period of time before it begins to show decrease in yield (See description of F1 Hybrid Seeds below). Table 3 shows selected Sorghum Hybrid varieties under adaptive trials by World Vision in South Sudan. Please note that this is different from F1 Hybrid which is described in the section below:

F1 Hybrid seeds

These are the result of cross pollination between unlike parents of hybrid seeds. The process of crossing pollinating two unlike hybrid seeds requires more diligence and expertise. This is because the parents are genetically different; the F1 will have "hybrid vigour" resulting in strong, vigorous plants and greater yield under good agronomic conditions. F1 plants are uniform. However, the F1 Hybrid seeds cannot be kept, stored or shared as seeds by farmers for planting in the subsequent season. Generally, F1 hybrid is not popular among subsistence and smallholder farmers because they require very high input such as fertilizers to manifest there true potential. Besides, farmers will always have to return to the seed source (marketer or company) to procure the seeds yearly.

Biologically modified seeds

These are seeds that results from modification of genetic of cells and organisms. This work usually takes place under a very highly scientific laboratory and rarely the type of subsistence or smallholder farmers will be involved. In these labs scientists modify the DNA of seeds to manifest their desired characteristics, which then takes prominence in the germ plasm. This involves cell slicing and could be extremely successful at completely altering cell composition of any seed type both in the lab and when they multiply them for commercial farming. Though there is no policy against the use of GMOs in South Sudan at the moment, the promotion of Genetically Modified seeds is discouraged by development practitioners mostly because it may require a huge amount of inputs to be successful, most of which the small scale farmer cannot afford. Unintended consequence of having GM seeds is the fact that there could be pollen contamination which may drift with wind rendering open pollinated seeds ineffective over time. It should be noted that the use of genetically modified seed is currently banned as MAFS is still debating guideline for its utilization.

Many development practitioners have stated that Hybrid seed varieties are not suitable for small holders and vulnerable farmers because of high input requirement and because farmers will not be able to keep the seeds after a season hence making the farmers more vulnerable as they have dependent on the large seed companies.

1.1	Sorghum	Macia	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	Kenya/ Uganda/South Sudan
		Sesso I, II, and III	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	Kenya/Uganda/South Sudan
		Kari mtama 1, 2	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	Kenya/South Sudan
		Wad Hamad	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	South Sudan/Sudan
		Gadam El Hamam	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	South Sudan/Sudan

Plant population and seed quantity required

Crops thrive and perform better when they are provided with adequate space that enables them stretch out to sunlight and are allowed sufficient space for root development, which means there is a reduced competition for soil nutrients and the water essential for proper growth.

The space required by a plant will also depend on the size (both height and width) of the plant at full development stage. In addition, the space a crop is planted will also depend on whether it is sole cropping, mixed cropping or a plantation crop, whether it is rain fed or under an irrigation system. Therefore, there are specific plant population or plant density for various crops.

Formula for calculating plant population:

$$Pp = \frac{10000m^2 \text{ x number of seeds per stand}}{\text{Product of spacing } m^2}$$

How to calculate Plant Population per hectare

1. The Plant population of any field is given by multiplying the between plants spacing with the spacing between the rows.
2. The total area of a hectare is 10000 square metres.
3. Divide 10000 by the result of multiplying the between plant spacing and the between rows spacing as given in as shown below

Plant population = 10 000

____

between plants spacing (m) x between rows spacing row (m)

An example
If the between plant spacing of tomatoes is 30cm and between row spacing is 90cm what is the plant population per hectare?

1. First convert cm to m 30cm =0.3m, 90cm =0.9 2. Multiply between plants spacing and the between rows spacing 0.3m x 0.9m = 0.27 sqm 3. Divide area of 1 hectare by 0.27sq m 10000 sq m / 0.27 sq m = 37037 4. Therefore Plant population of potatoes per ha is 37037 Go on and calculate your plant population and make the right decisions in farming

The table below shows plant population for selected crops.

Table 3. Plant density recommendation for some specific crops under mono cropping and rain fed conditions

Crops	Plant Spacing	Plant Population per hectare
Maize	30 x 60cm / 75 x 50 cm	50,000
Sorghum	40 x 40 cm / 75x 30 cm	100,000
Cowpea	1.0x1.02m/75x20-50cm	50,000
Cassava	1.0x1.0m / 75x75cm	10,000
Soybean (Glycine max Merill.)	75x5 cm	266,700

Seed (and planting material) Production Protocol

The seed production process or protocol should start with proper identification of the seeds bearing a clear scientific name, the origin of the seed distribution and the description of how it was produced.

The protocol for the production of planting materials including seeds from clean planting material source should include the following:

- Field facilities and equipment
- Source of material, including positive selection
- Field requirement
- Field inspection
- Agronomic practices such as isolation, rotation and negative selection
- Harvesting and handling
- Post-harvest treatments
- Storage and transport
- Quality standards for the supplied product

Steps for producing good quality seeds

Source of foundation seeds

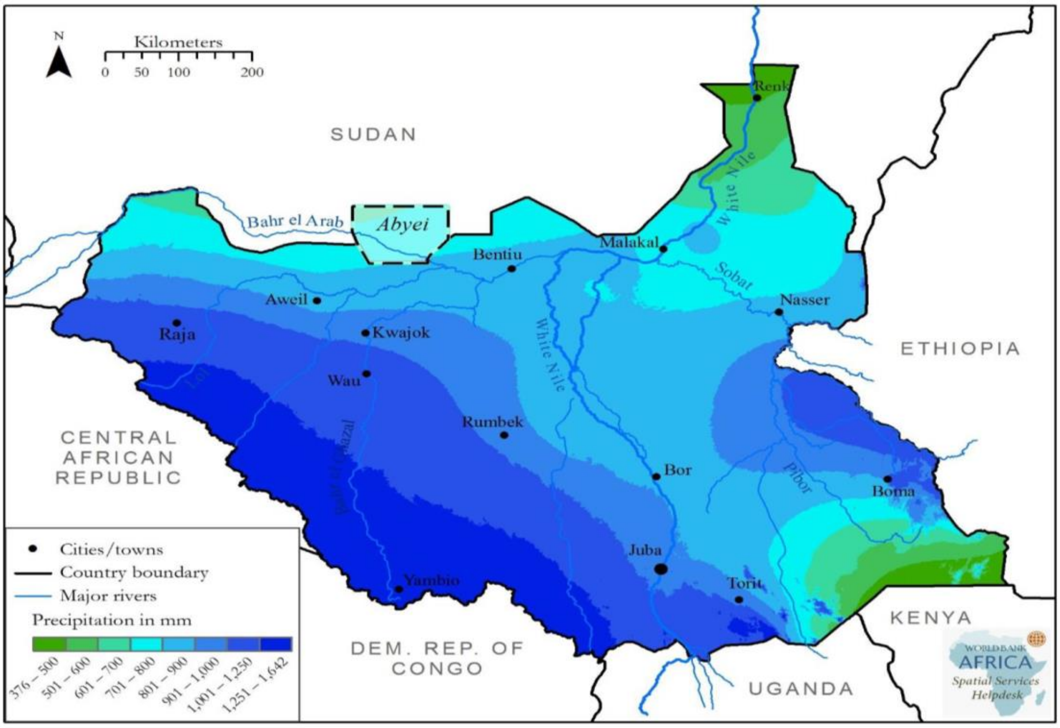
Producing good quality seeds starts with a complete understanding of the protocol guiding production. The quality of seeds to be produced thus begins from the choice of seeds, the agro ecological condition, the treatment and the cultivation practices the seed stock is subjected to. Often farmers see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

Soil type and climate

Different crops require different type of soils. But most cereal crops thrive best in light- to medium-textured soils. Though sorghum for instance can tolerate a soil pH of 5.0 to 8.5, also for most crops (with the exception of low land rice) the soil you choose should preferably be well aerated and drained including most cereals.

Most of the South Sudan has a sub-humid climate. The rainfall varies across the country (map 2.5), gradually decreasing from south to north, from approximately 1,800 mm to 500 mm; the northern areas are dryer and experience more frequent drought. There is abundant annual precipitation in the south and southwest areas, about 1,500 mm, but much less (about 500 mm) as one moves from south to north.

The map below shows the annual rainfall across South Sudan.



[1]

Basic agronomic practices for most cereal crops

Understanding soil types, soil acidity and alkalinity measured by ph level; and determining soil fertility levels we need to consider climatic conditions such as rainfall, precipitation, amount of sun shine and recent unpredictability of weather condition; . In addition it is important to carry out appropriate agronomic practices. A few of the agronomic practices common to cultivation of annual crops such as cereals and pulses are described and illustrated below.

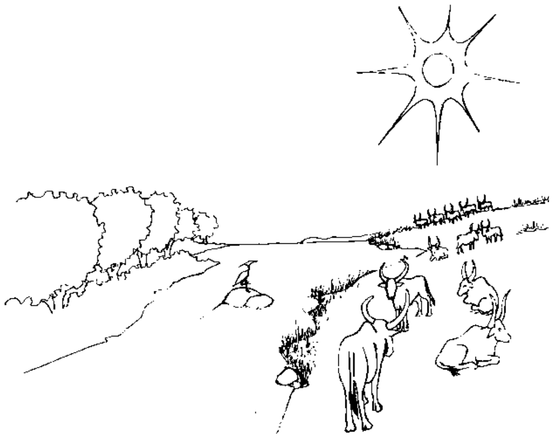
[1] World Bank 2013: The Rapid Water Sector Needs Assessment and a Way Forward

Site Selection

Sorghum as an example for a staple cereal crop grown by most farmers in South Sudan and in the tropics where it is well exposed to sunshine. It is also widely grown in temperate regions and at altitudes of up to 2,300m.

Well drained soil is preferable and areas of land that are waterlogged must be avoided. Preparation of land should be done as early as possible at the start of the rains.

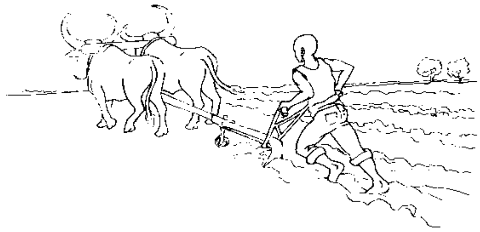
When selecting a site for cultivation, it is important to choose areas that are safe from animals and theft and choose areas which are well suited to animal traction (ox ploughing), especially if there is a desire to expand the area under cultivation.



Land preparation

This is mostly through brushing of undergrowth and felling of some trees. It is advisable to undertake two separate types of land preparation practice (tillage): primary (general) and secondary (fine seedbed) preparation.

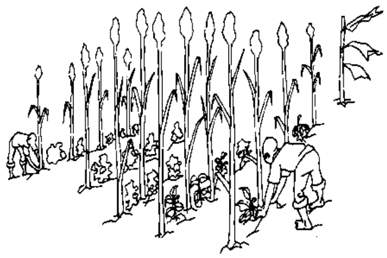
The tools commonly used by smallholder farmers is South Sudan are hoes (maloda/pur) and the ox plough (pur weng), while tractors are used for land preparation by large-scale farmers.



Sowing of suitable seed variety

Seeds should be wholesome (free of physical damage, pest infestation and disease) and should be adequately dried before being stored in a clean and well-ventilated area. Farmers are encouraged to procure their seeds from the reliable seed suppliers and to use certified seeds where available. Seeds should come from a stock kept in good condition in order to preserve their viability.

Row planting is the preferred method because it ensures optimum plant population, higher yields and the development of good-quality grains. Seeds are planted or placed at a shallow depth of approximately twice the size of the seed.

Irrigation This is the application of water to the crops. In South Sudan, rainfall provides water naturally and most farmer wait on the rains for main season cultivation. In the dry season, planting is done near the water sources which could along the river banks, reservoir or open wells. Though not many farmers do dry season Sorghum but Maize is becoming common. Water is brought using watering cans and in some cases through treadled or motorised pumps.	
Weeding For most annual crops, timely weeding is recommended. On small holder farmers farms this is done using hand hoes (maloda and jembe) with wooden handle. For sorghum for instance it is advisable to weed twice (by the third and sixth week).	
Thinning Thinning is carried out at the same time as hand weeding, or at intervals during the crop cycle, particularly where thinnings are used to feed livestock. Gapping by transplanting thinnings is encouraged when thinning is done within 2 weeks after emergence and when the soil is moist.	Illustrate
Harvesting and Harvesting techniques For seeds, harvesting is best done when crops are fully matured and the fruits are drying. On small holder farmer we encourage that seed bunch is reasonably dry on the crop before harvest. Further drying will be needed to reach the 15% moisture content for good storage and to be processed into seeds.	

Common pests in the field on cereals to note are the Fall Army Worm (Spordoptera frugiperda), Birds and Grasshoppers. Fall Army Worm has been reported to have a devastating effect on plant population and yield which may result to food shortages in the areas where prevalent. Apart from applying the appropriate pesticide, good agricultural practices such as timely planting, timely weeding, spacing, use of manure and fertilizers to ensure that plant stay healthy, farmers are also advised to scout out for the egg masses, scout for the caterpillar and destroy them. Intercrop maize/ sorghum with beans, cowpeas, ground nut or soybean to help reduce the spread. The use of area wide management (collective action) rather than farmers acting individually is important to prevent spread from one farm to the other. It is also important to avoid moving one infected plant to a non-infected area.

Common Disease in the field affecting Sorghum

A notable disease that affects sorghum is Smut which attacks at the seed development stage. Grain mould is another (fungal) disease that affects medium-maturing varieties of sorghum (and all varieties when stored). Mould can grow in grain stores due to moist air and limited ventilation. The selection of very clean and healthy seeds that are free of disease can also help to reduce the incidence of smut.

Stem borer disease is also very common, but can be controlled effectively by ensuring good field hygiene, regular weeding and the destruction of host crops. Other diseases of sorghum include anthracnose and leaf blight.

Soil Fertility and Fertilizer Application:

To be added:

1. Organic

2. Inorganic

Understanding Growth Stages of Sorghum

Growth stages of crops vary from crop to crop. For the purpose of understanding the process of identification of most cereal crops the example used here is of Sorghum which commonly grown by farmers across South Sudan. The growth of Sorghum is spread over 9 stages, from emergence until physiological maturity.

Stage 0. Emergence
Stage 1. Three–Leaf Stage;
Stage 2. Five–Leaf Stage;
Stage 3. Growing Point Differentiation stage;
Stage 4. Final Leaf Visible in the Whorl Stage;
Stage 5. Boot Stage;
Stage 6. Half Bloom Stage;
Stage 7. Soft Dough Stage;
Stage 8. Hard Dough Stage;
Stage 9. Physiological Maturity Stage.

The time required to reach each stage depends both on the hybrid and the environment in which it is growing. The times presented are for comparative purposes only. They would change for the same variety at the same location if the planting date was changed or if results from two seasons were compared. Other factors such as soil fertility, insect or disease damage, moisture stress, plant population, and weed competition may also affect both timing of the various stages of development and condition of the plants at each stage of development.

Isolation (by time and by space)

It is important to note that not all crops are pollinated by insects such as bees. The vast majority of grains producing crops are pollinated by the wind. This happens when pollens are carried by wind and deposit on another individual of the same type or of similar varieties. It is therefore important that farmers producing certify seeds should ensure that their field have a sufficient distance from any neighbours' field growing the same type of crops.

The most convenient way for instance is to grow Sorghum in a field where other farmers around you have Maize or Millet. Some crops are self-pollinating such as groundnut so requires shorter isolation distance. The rule is not to grow a crop meant for seeds close to a crop of the same variety to avoid contamination and cross pollination. The recommended Isolation distance is shown in the table below.

Table 4: Field isolation distance and sowing requirements for seeds farms

Crop Type	Isolation distance (m)	Date of sowing	Seed Rate (kg/ha)	Plant Spacing (cm)	Depth of sowing (cm)	Plants per stand
Maize	400-600	June/July	20-25	75 x 50	3-5	2
Sorghum	200-400	June/July	10-15	75 x 40	3-4	2
Rice	5-10	June/July	40-50	25 x 25	2-4	4-5
Millet	200-400	June/July	3-5	75 x 50	2-3	2-3
Soybean	5-10	June/July	40-50	75 x 20	2-3	5-6
Groundnut	5-10	June/July	35-40	75 x 25	3-5	2
Cowpea	5-10	July/August	25-30	75 x 20-50	3-5	2

Adapted from PROSAB IITA 2008

The illustration below showing the planning of farm location and the surrounding farmer plots to reduce cross pollination to its minimum.

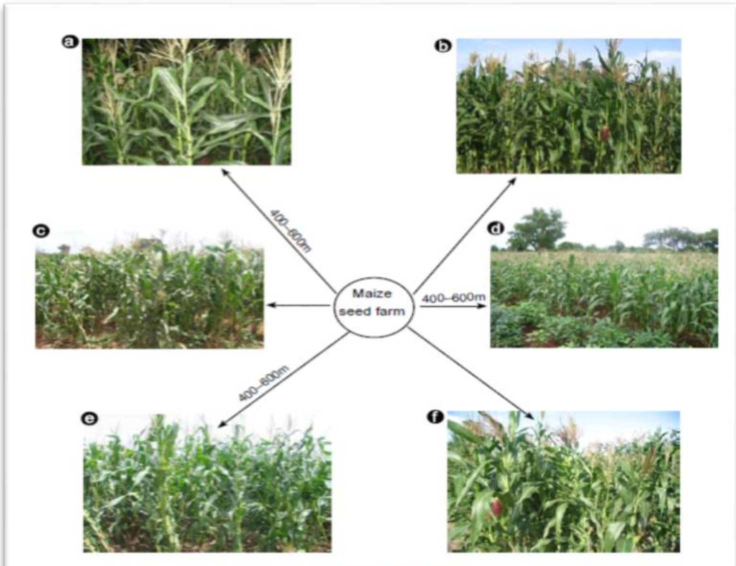
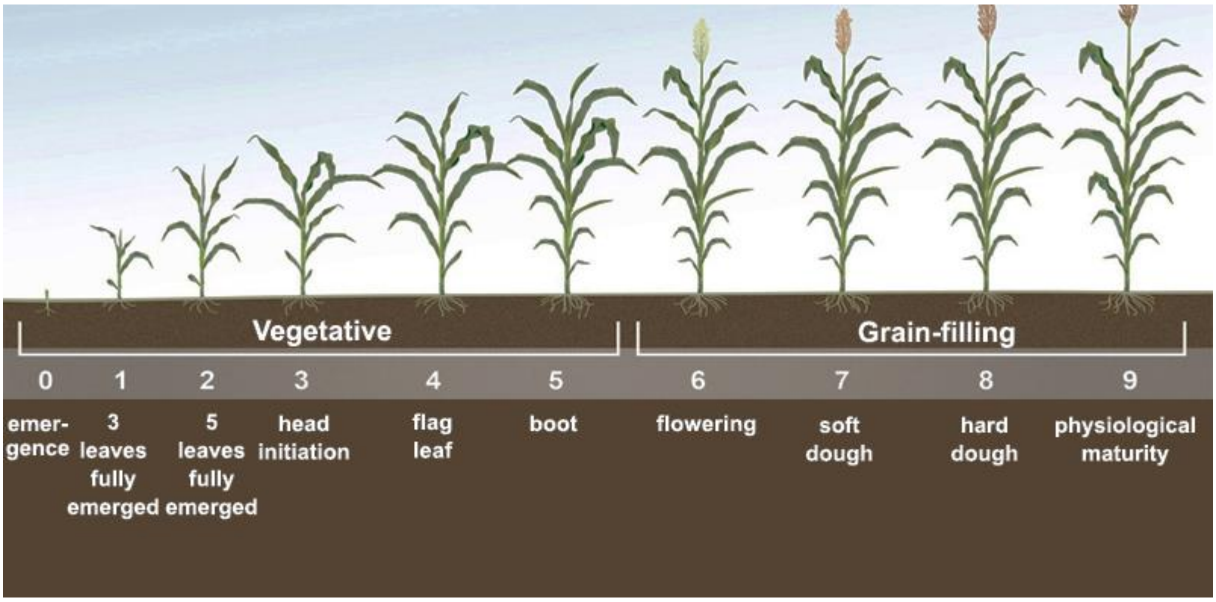


Figure 3. Isolate the maize seed farm from the nearest neighboring maize fields by a distance of 400–600 m in all the directions represented by arrows to avoid variety contamination from cross-pollination.

Apart from ensuring distance, another alternative way of ensuring that isolation takes place is to plant crops meant for seeds at a different time in the season. Research showed that if you delay planting by a couple of weeks when other farmers around you have already planted, your crop stand a good chance of producing clean seeds because it will only come into maturity a little later than others. The illustration below shows the growth stages of Sorghum.



Adapted from Pioneer Seed Inc

Based on the understanding of the growth stage, seed farmers could delay sowing by a couple of weeks. However depending on the season and arrival of rains, and the unpredictable season in recent time, extensionist and farmers considers delayed planting as impractical especially where irrigation facilities are minimal or nonexistence. As an alternative, planting a crop type different from the crops grown by neighbouring farmers has proved an excellent strategy that ensures very good isolation and curbed the problem of contamination.

Characteristics and quality of good seeds

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

There are four basic attributes of seed quality to consider:

1. Physical qualities of the seed in a specific seed lot
2. Physiological qualities observes germination and vigour of seeds
3. Genetic quality which relates to specific genetic characteristics of seed variety

4. Seed Health which refers to the presence of diseases and pests within a seed lot (Phytosanitary)

   These attributes and its realisation is what farmers here describe as "seed purity"

Physical characteristics

Physical characteristics: Observing physical characteristics of seeds is an important first step of checking and determining whether a seed lot is good or not. We use our senses of seeing, touching and feeling to determine the quality of the seed.

At this stage farmers should look at:

- size of the seeds (width),
- their length (how long),
- their weight (if too light they could be empty or full of chaff),
- their shape (comparing them to what is desired and what you think it should be),
- surface texture (mostly of the coat, if is it coarse or smooth, cracked or wrinkled),
- colour (is the seeds of the desired colour? is the colour artificial? Is this what the market want?),
- has it be affected by too much moisture or exposed to too little sunlight (if it's affected by moisture it could be mouldy and even smell badly).

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

Physical seed moisture content test using teeth

Farmers in many regions in South Sudan test seeds by attempting to crack the seeds with their front teeth. They do this to determine how dry or wet the seeds are. A very dry seed is usually harder to crack, which means that it's probably having lower than the required 15% moisture content.

Another simple method is to shake a sample of grain with dry salt in a clean dry glass jar for several minutes. If the salt sticks to the sides of the glass jar, it means the grain moisture content is above the safe moisture content level. If the jar

surface is clear of salt, it means the grain is dry enough to be put in storage
It is important to note that this is not all together scientific and it's prone to many inadequacies. There are simple moisture meters nowadays that can be used to read seed moisture content either in the laboratory or on the farm stead.

Therefore from physical examination it should be possible to see and confirm that seeds are free of contamination and from contaminants such as weed seeds, other variety of seeds, inert material which are usually not of plant origin such as plastics, papers, metal and so on; it is also possible to identify damaged seeds and seeds that are completely off size (this could mean that they are not fully formed hence are too small in size or that they are just too large).

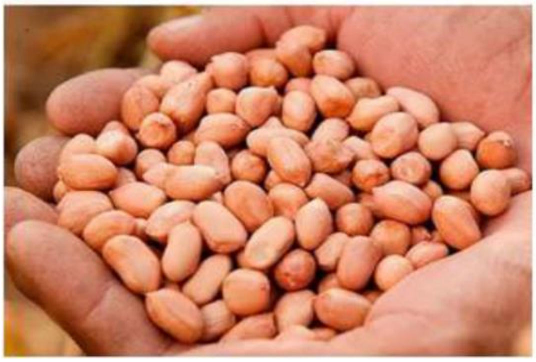
Physiological Characteristics of seeds

This examination refers to the observation of the germination and vigour with which a sample of the seed lot germinates when tested under a potentially stressful condition. Just as the physical attributes are about the things seen under visual examination, these checks examine the performance of the seed. In other words, it checks how the seeds will germinate when sown. With this a judgement it is possible to make a preliminary judgement about how the seed will grow rapidly in real field conditions. Most farmers and practitioners in the field often look only the germination percentage or germination count ignoring the observation of vigour. It is important to note that a seed with high germination rate can have poor vigour rate and that seeds with initial high vigour rate can deteriorate over time due to storage conditions and transportation system used.

Phytosanitary attribute of Seeds

Seeds are biological so they can be affected by diseases which may be caused by microorganisms such as bacterial, fungi and viruses or caused by other organisms such as pests. Unlike physical examination except for mould, it is not always very easy for small scale farmers or subsistent farmers to spot these when they examine seeds because most of them are invisible to the naked eyes (microscopic). Groundnut Seeds contaminated by Aflotoxin. (Picture inset shows aflatoxin infection on Groundnuts)

Source of photograph: UNIDO post-harvest training manual



Other than observing moulds some of which are colourful and feeding on the outer coat of seeds, many disease-carrying seeds cannot be easily detected. For instance, tomato seeds are known to carry fusarium, nematodes and verticillium pathogens which cannot be seen but can grossly damage seeds or plants when sown. Where seeds are observed to be infested with insects in store or in transit, they should be fumigated using an appropriate chemical and, as most of the smallholder farmers are already practising, by applying chillies to seed lots if stored in small containers or sacs.

Therefore, this characteristic of seed quality should be taken very seriously. Unfortunately, these can only be undertaken in laboratories by experts.

Seed viability testing

Viability testing describes the various type of tests run to determine what percentage of the seed lot will yield acceptable seedlings. This is important because the test will help farmers know how much to sow to obtain the desired plant stand per area under cultivation. The other aspect of viability is the determination of the vigour rate of a seed lot.

Determining Seed Germination Percentage

1. Seed viability test using water and a bowl

Farmers have used this old method and the majority of smallholder farmers have come to trust this method over. This method uses the weight and density to determine viability by observing seeds that settles at the bottom of the bowl and the seeds that floats on top of the water. The logic is that floating seeds are unfit for planting because they are too light or infested by weevils.

2. Seed germination test using plate method

In this case, farmers take a few seeds (usually 100), they sow them in a plate with moist tissue paper (if done at home) or in the farm where the 100 seeds are sown (planted) on a small area suitable for pre-nursery. The plate is covered (if it is in prenursery site, the seeds are sown with water sprinkled to ensure that the soil is moist). Either way, they are left undisturbed for a few days (4-5 days) in South Sudan where temperature is relatively moderate and germination is expected to be fast. On the fifth day, the plate is opened and the number of germinated seeds is counted.

To calculate the germination percentage, divide the number of seeds that germinated by the number of seeds you sow, then multiply by 100.

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

Seed Vigour testing

Seed vigour is described as the sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence. Determining seed vigour is very important because it cannot be easily detected by physically examining seeds yet, to a farmer, it is about the most important factor of good quality and certified seeds. Those seed properties which determine the potential for rapid, uniform emergence, and development of normal seedlings under a wide range of field conditions

Vigour tests can help predict:

- Rate and uniformity of seed germination and seedling growth
- Field performance, including extent, rate and uniformity of seedling emergence
- Performance after storage and transport, particularly the retention of germination capacity

Vigour testing is not a substitution for germination testing. Both are tests of seed viability, but they measure different sides of that coin.

Table 6: Stages of seed growth and examples of seeds germinating in the nursery

A germination test tells you what percentage of your seed lot will start to grow under ideal conditions. A vigour test, on the other hand, is an indicator of how that seed will perform under less than perfect environmental conditions, taking into account the seeds' genetic constitution, size, physiological maturity, and any effects related to production and storage the previous year.

Seed vigour testing measure basically two properties of a seed lot. These are:

1. Emergence: Describes the percentage of seedlings that developed normally and rapidly under cold conditions.
2. Vigour: This is the percentage of seedlings that have reached the minimum criteria to be considered high vigour.

The benchmark for a high vigour seed lot is 80% emergence and 60% vigour. Expected field performance falls between the vigour and emergence values under a wide variety of field conditions, and is significantly better when field conditions are ideal.

Therefore, seed vigour testing could be classified into both Direct and Indirect test

Direct: those in which an environmental stress expected in the field is reproduced in the lab and the percentage and rate of seedling emergence is recorded (e.g. cold test).

Indirect: These are those in which other characteristics of the seed which have proved to be correlated with an aspect of field performance are measured (e.g. respiration rate, conductivity test)

There are several vigour testing methods which could range from simple to a slightly more complex method.

Examples of vigour testing methods are:

- Seedling Growth Rate Test
- Accelerated Aging Test
- Controlled Deterioration Test
- Electrical Conductivity Test
- Potassium Leakage
- Computer Imaging
- Terazolium Test

For the purpose of this manual the **seedling growth rate test**, the **accelerated aging test**, and **Terazolium** are described because of the practicality to relative ease of doing this in a field or adaptive research condition.

Seedling Growth Rate Test

This test is closely related to the standard germination test (described in the previous section) and is useful to figure out field planting potential under optimal or near ideal conditions.

Seeds are planted under optimum conditions and are allowed to grow for an extended period of time, usually several days past the typical germination period. The seedlings are evaluated by their growth characteristics, such as stem length, leaf development or root branching.

The measurements determining strong or poor vigour are highly dependent on the particular cultivar being tested. Some varieties of lentil, for example, may naturally be longer than others. It means our seed analysts have to get very familiar with a lot of different growth characteristics!

Cold Germination Test

Cold germination tests assess the seedlings' ability to withstand the low temperature stress (5^0C to 7^0 C) typically experienced in early spring planting.

Cold Test can be carried out in the following forms:

- Tray method
- Shoe box method
- Rolled towels method
- Saturated cold test

This test helps you better assess early season risk. In other words, if test results show the seed is susceptible to cold stress, you can adjust your seeding dates accordingly.

The cold germination test results are reported in two categories:

- Emergence is the percentage of seedlings that developed normally and rapidly under cold conditions.
- Vigour is the percentage of seedlings that have reached the minimum criteria to be considered high vigour.

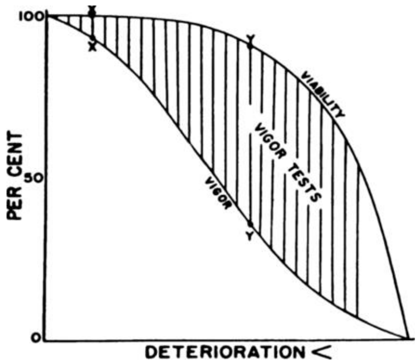
The benchmark for a high vigour seed lot is 80% emergence and 60% vigour. Expected field performance falls between the vigour and emergence values under a wide variety of field conditions, and is significantly better when field conditions are ideal.

Tray test is the oldest method of determining seed vigour and germination.

Steps in Cold Tray test

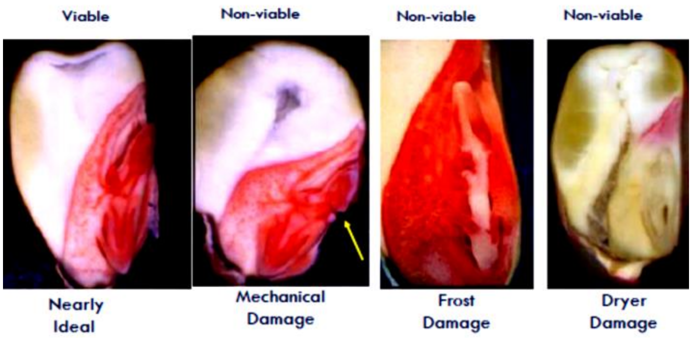
- Place one sheet of CCP on each tray and add 1100 mL of water
- Place trays in cart overnight at 10oC cold room.
- Plant 4 samples per tray (2 reps per student). Press down seeds.
- Add 4:1 sand/soil mixture.
- Move cart to 10^0 C cold room (without light) for 1 week.
- Move cart to 25^0 C with exposure to vertical lights to rear of cart.
- Evaluate samples on day 5-7* according to AOSA Rules.

The report of seed vigour germination test can also be represented on a graph



Tetrazolium test

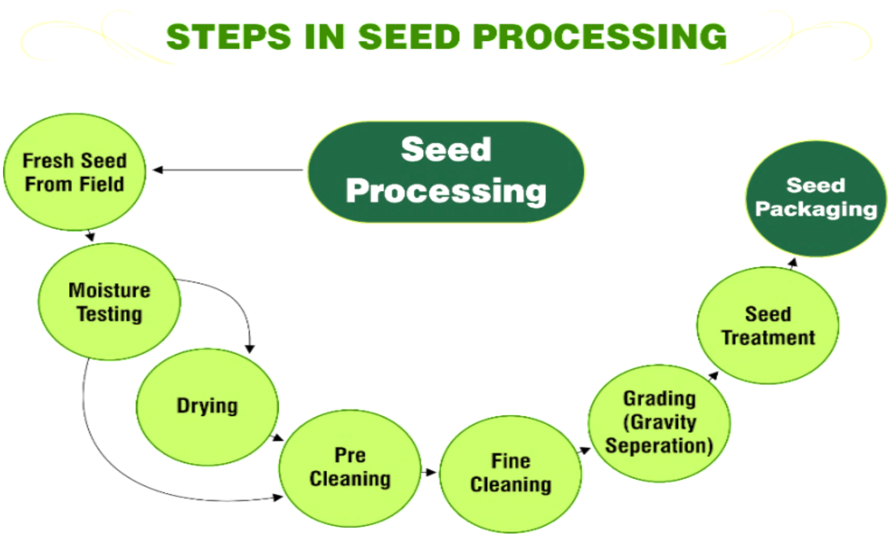
The tetrazolium test is an important method providing fast assessment of the seed physiological quality. Test can be used to determine viability as well as vigour. Tetrazolium vigour tests for example, measure vigour indirectly, and therefore treat vigour as an intrinsic property of the seed. This is usually carried out in laboratory by qualified scientists.



The use of tetrazolium is to determine which seed tissues are alive and have the potential to germinate under optimum conditions. Tetrazolium is a colourless chemical that reacts with living cells and stains them red. Tetrazolium tests are particularly good for detecting heat-damaged seed as this kind of damage creates a unique staining pattern. With a tetrazolium test it is possible to detect the very early stages of heat damage. Mechanical damage to the seed embryo and sprouting can also be assessed with tetrazolium.

- Tetrazolium salt (2, 3,5-triphenyl tetrazolium chloride) is colourless
- Reacts with hydrogen released during respiration to form water-insoluble formazan (red)
- Seed must be imbibed prior to testing to initiate metabolic pathways of respiration
- Evaluation of staining patterns of critical areas of the embryo
- Useful in a wide range of species

Seed Processing



Seed processing is a post-harvest activity. It is processes that involve preparation of seeds for market and for farmers use by removing all unwanted materials from a seed lot. Seed processing is very crucial for certification and it is important for attracting good prices in the market. The process ensures that seeds are separated from inert materials, common weeds seeds, noxious weed seeds, deteriorated seeds, damage seeds, other crop seeds, and other variety of seeds and off size seeds.

We already know that seeds are of different colours, sizes (length, width), weight, surface structure, shapes and also moisture content. Collectively these characteristics define the physical qualities of seeds.

There are various levels of processing. Ranging from simple or basic which can be done by small holder farmers in a relatively less complicated situation; to industrial level seed processing that requires highly mechanised system of seed processing often done through the use of specialised equipment and could be highly scientific.

Fundamental seed processing steps include:

After receiving the seed lot coming in from the field or aggregating centre, the first step is to drying the seeds. Air them. Drying is necessary to ensure the right moisture content, receiving (including aggregating or bulking).

Pre cleaning: During the pre-cleaning process, undesirable elements such as large impurities, sand, thin grains and weeds are to be separated. During this process it is important for the cleaning process to eliminate heavy impurities, such as stones, metallic particles and other foreign bodies from seed products

Fine cleaning (removing all off types and ensuring phytosanitary conditions are met as much as possible). At this stage the seeds are further examined to pick out mould and seeds that shows diseases (that are visible) on their coats.

Sorting and Grading into sizes (ensuring that the seeds have just enough food to sprout, hence not too large and certainly not too small compare to the average size of the crop);

Treatment: at this point seeds could be further dried, aired and in many cases coated with approved agro chemicals which have anti-microbial or fungicidal active ingredient. Seed dressing happens at this stage.

Packaging (bagging is the right bag types that will ensure adequate aeration or ensures complete vacuum);

Storage: Seeds are then transported and stored (in a pest free shelter, on pallets in locked up stores and away from walls to avoid damp) before they are marketed.

The illustration below shows simple practices by small scale farmers in South Sudan and across the African sub regions:

Seed Cleaning by winnowing Winnowing is a basic techniques of cleaning dry seeds. It ensures that seeds are cleaned based on their differences in specific gravity. It is usually done by hand using a tray or a fanner. It is best done where there is wind. The seeds along with chaff are allowed to drop from a height of several feet (about shoulder level of an adult) with the wind blowing, as they drop with the wind blowing gently through them, the seeds are separated from chaff and other light unwanted materials. With some skills and the wind, the clean seeds will fall closer unto a sheet, tarpaulin, mat or container while the chaff will fall further away in a distance because seeds are heavier.	
Grading and Sorting of seeds Seeds are further made cleaner through grading and sorting. At this stage involves the use of at least two sieve sizes with varying mesh sizes. One should be a little large. The two sieves are placed over each other. The first will allow anything smaller than the desired seed size to pass through while the other will hold the seeds with the larger size.	

Seed Dressing

Seed dressing is commonly used fungicides or antimicrobials for dressing seeds before sowing. Dressing is a first protection treatment; basic and the cheapest way to fight with pathogens in the soil and relocated with seeds. Seed dressing is the most common method of seed treatment. The seed is dressed with either a dry formulation or wet treated with a slurry or liquid formulation of the seed treatment chemicals. Dressings are applied both industrially and on-farm. See Annex III for the Required Conditions for Seed Treatment in an FAO-Supported Intervention.

Methods of Seed Dressing

Seed treatment describes both products and processes. Using specific products and specific techniques can improve the growth environment for the seed, seedling, and young plant.

Seeds dressing can be of many kinds it can either be drying techniques to avoid moisture content in the seeds or through wet techniques with which the seeds are actually soaked in the nutrients and vitamins solution.

Seed coating is also a process of seed dressing where colours are applied to the seeds to save them the birds. These colours make them invisible to the birds.

Seed pelleting is also the process of seed dressing in which the shape of the seed is changed to enhance the plant handling.

Benefits of Seed Dressing

- It is useful for uniform establishment and growth of the crop.
- It enhances the seed germination process.
- This treatment is better than the foliar application and the soil application.
- Protection is provided for seed germination and seedlings against the soil borne insects and it also controls the soil insects.
- Plants withstands even in the adverse conditions like more or less moisture levels.
- It prevents the plants from diseases and also the spread of plant diseases.

It is vital that farmers invest in getting their seed dressed before sowing as it will help them in getting better yields.

Seed cleaning and dressing cannot be undertaken single-handedly as it requires use of modern techniques and adequate time. Since farmers may not be in the position to invest substantial time in such processes, it is vital to seek assistance from a reputed seed cleaning and dressing agency.

Identifying good quality certified seeds

Merely looking at a seed stock cannot assure a farmer of the quality of a seed as we have said in the previous section. However, good quality seeds which have been certified by the authority will be accompanied by a label with:

- Name of seeds (Written in bold letters)
- Variety of the seeds
- Year of production
- Expiring dates of seeds (most times printed)
- Phytosanitary certificate: Certification number and batch number (usually on labels) should be bold
- Germination Percentage clearly indicated

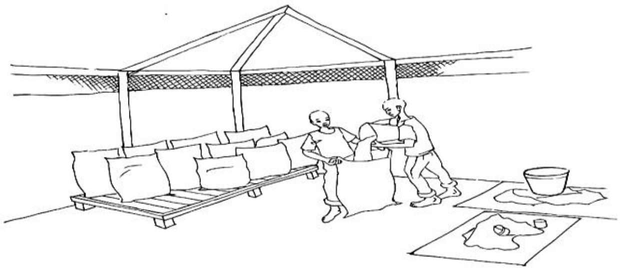
Seeds Packaging and Storage

There are three critical factors that affect grains in storage whether they are kept as seeds or are for consumption. These are: Temperature, Moisture Content and Relative Humidity.

All three factors affect the quality of seeds in storage because they may produce the right conditions for pests and diseases to grow.

Temperature: Storage insects and mould thrive within an optimal temperature range: between 25 ºC and 34 ºC for most storage insects, and between 15 ºC and 30 ºC for the development of mould. Beyond this range (colder or hotter), the development of these threats to the stored products is limited, and therefore the losses as a result are negligible.

Please note that while high temperature could be fine for seeds for consumption, seeds for planting will be physiologically damaged when exposed to a very high temperature.



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

Relative humidity is the percentage of water vapour in the air between the grains, and represents the equilibrium between the humidity of the air and the moisture content of the grain. If the relative humidity exceeds 65 percent, mould and storage insects can develop and stored grains and seeds are susceptible to deterioration.

As a general rule, the lower the temperature, relative humidity and moisture content, the lower the risk of grain damage and reduction of the germination capacity.
The best is to harvest fully matured crops and dry them well before storage.

Traditionally in South Sudan seeds are stored by subsistence farmers and smallholder farmers in four ways namely: Household granaries, Gourds, Bags, metal storage bins and the Hermetic Bags (Double lining bags).

Figure 1: UNIDO Household seed storage metal bins or silos

Additionally, seeds can be stored in an improved storage bins (silos) made out of galvanised metal sheets. Silos come in different sizes and in different scales. Some are highly mechanised and monitored scientifically to ensure the balance between moisture, relative humidity and temperature. Small metal silo bins (including recycled oil drums Figure 1) which can hold 100 to 3 000 kg of grains or pulses, are developing as an efficient and low-cost storage system suitable for small-scale farmers. These silos are loaded from the top, and once closed they are inaccessible by rodents or insects, and can be properly sealed against water leaks. They are normally covered, raised from the ground and placed in a well-ventilated place to control both temperature and humidity.

Figure 2: Hermetically sealed bags

Source of photograph: UNIDO post-harvest training manual

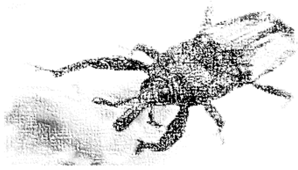
FAO's work on post-harvest losses and seed storage shows that though hermetic bags are recent and new the hermetic bags can be effective for storing most seeds. These hermetically sealed bags or cocoons are available in various sizes (50 kg–300 MT); they offer an interesting alternative to traditional storage. The hermetic bags work on the principle that grains release carbon dioxide which rapidly replaces the oxygen in the sealed container. Once oxygen is exhausted, the pests die and fungi cannot spread.

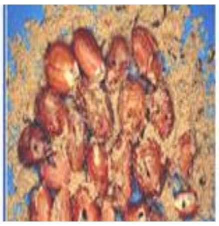
Figure 3: Traditional household Granary in South Sudan and Improved Grain Silos

Traditional household Granary — Grain Silos (improved and large scale granary)

Source of photograph: World vision south sudan

Common storage pest for selected crops and how they can be identified

Crop Type	Common storage pests	Images
Maize (Zea mais)	**Maize weevil (Sitophilus zeamais Motschulsky).** Maize weevil, also called greater grain weevil is the most common pest of stored maize in most African countries. Attack may start in the mature crop when the moisture content of the grain has fallen to 18-20%.	
	Larger grain borer (Prostephanus truncatus (Horn) Adults are black or brown and cylindrical in shape, heads face down. Slightly larger (3 to 4 mm) than the lesser grain borer. Posterior end of the elytra slope back with two strong lateral ridges with sharp edged corners. Larvae are grub-like with poorly formed legs and are less mobile as they mature. Primarily affects maize but also affects dried root crops, bamboo, rattan, cassava, wheat, sorghum, dried sweet potato. They will bore into, but does not feed on, cowpea, cocoa, haricot, coffee, rice	
Sorghum (Sorghum bicolor)	**Larger grain borer (Prostephanus truncatus (Horn)** Adults are black or brown and cylindrical in shape, heads face down. Slightly larger (3 to 4 mm) than the lesser grain borer. Posterior end of the elytra slope back with two strong lateral ridges with sharp edged corners	
Rice (Oryza sativa)	**Rice weevil (Sitophilus.oryzae).** These are a storage pest that bores into the grains and grinds the interior soft content of the grain;	
	Termites These are ants which affect rice both in the fields and in the store	

	Rodents These are usually rats and can be a major problem. Farmers should set rat traps if available (or get a cat). In all cases farmers should be encouraged to check the rice regularly for signs of spoilage and/or pest infestation.	
Millet (*Pennisetum glaucum* [L.] R. Br.)	**Larger grain borer (Prostephanus truncatus (Horn)** Adults are black or brown and cylindrical in shape, heads face down. Slightly larger (3 to 4 mm) than the lesser grain borer.	
	Khapra beetle (Trogoderma granarium) Adults are small (2-3 mm long and 1-2 mm wide), brownish in colour with a smooth oval shaped body. There are 3 transverse bands (markings) of pale colour hairs on the wing covers. Eggs hatch into small hairy larvae that can grow up to 7 mm long, are reddish brown in colour and darken as they mature.	
Groundnut (Arachis Hypogeal)	**Groundnut bruchid, Caryedon serratus (Olivier). Coleoptera: Bruchidae** The adult is a brown beetle, about 4-7 mm long and 5 mm wide with prominent large hind legs (Fig 1). A single gravid female lays 20-30 creamy white eggs (1 mm long), which are glued to the surface of roundnut shell or kernels[2]	 
	Red flour beetle, Tribolium castaneum (Herbst) Coleoptera: Tenebrionidae. Red flour beetles attack stored groundnuts and other grain products The adults live for several months and are strong fliers. The female lays eggs in cracks of the testa or on the damaged portions of the kernel to enable the young grub to feed on the kernel directly.	

Cowpea (Vigna unguiculata)	**Cowpea bruchids (*Callosobruchus* spp.)** They are the most common and widespread insect pests in storage. Adults are 2 to 3.5 mm long. They are major pests of pulses (cowpeas, pigeon peas, soybean, green gram and lentils). They attack both pods in the field and seeds in storage. They attack nearly mature and dried pods. Infested stored seeds can be recognised by the round exit holes and the white eggs on the seed surface. Post-harvest losses are highly variable, but losses can be over 90%. [3]	

Control of major storage pests

While adults are the signs of an infestation, merely killing them is not sufficient and cannot be the solution. Infested seeds lots and bags must be found and destroyed. Identification of the pest can provide clues on where to look but some of these insects can live on a wide range of materials. Disposal of infested materials is the best way to eliminate the problem. After treatment, good sanitation and proper storage are keys to preventing future problems. Based on FAO, UNIDO and many implementing partners direct field experience supported by evidences in science alert journals, the following explains the different storage pest control methods.

Physical control: Insects in stored grain can be controlled by manipulating the physical environment or applying physical treatments to the grain and insects. The variables defining the physical environment that are usually controlled are: temperature, relative humidity or grain **moisture content** and relative composition of atmospheric gases in the intergranular air. Physical treatments include mechanical impact, physical removal, in addition there is also physical barriers to prevent the entrance of insects, abrasive and inert dusts, ionizing irradiation, light and sound.

Fumigation: Fumigation is a method of pest control that completely fills an area with gaseous pesticides to suffocate or poison the pests within. It is utilized for control of pests in buildings, soil, seed and grain produce. It is also used during processing of goods to be imported or exported in order to prevent transfer of exotic organisms. Fumigants are chemical compounds in gaseous form that enter the body of insect through the spiracles spread all over via trachea and tracheoles.

Microbial control: Synthetic chemical insecticides provide many benefits to food production and human health, but they also pose some hazards. In many instances, alternative methods of insect management offer adequate levels of pest control and pose fewer hazards. One such alternative is the use of microbial insecticides that contain microorganisms or their by-products. Microbial insecticides are especially valuable because their toxicity to non-target animals and human is extremely low. Compared to other commonly used insecticides, they are safe for both the pesticide user and consumers of treated crops.

Annex 1: List of Seed Varieties Officially Released for Use in South Sudan

1.0	Cereal Crops	Varieties		Agro-ecological zones	Potential Seed Source
1.1	Sorghum	Macia	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	Kenya/ Uganda/South Sudan
		Sesso I, II, and III	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	Kenya/Uganda/South Sudan
		Kari mtama 1, 2	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	Kenya/South Sudan
		Wad Hamad	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	South Sudan/Sudan
		Gadam El Hamam	Open Pollinated	Ironestone, flood plain, Arid, Hill & mountains, and parts of green belt	South Sudan/Sudan
1.2	**Maize** (HYBRIDS)	KH500-44A	Hybrids	Green belt, Hills and Mountains and Ironestone zone	Kenya
		KH500-22A	Hybrids	Green belt, Hills and Mountains and Ironestone zone	Kenya
		Longe 6H	Hybrids	Green belt, Hills and Mountains and Ironestone zone	Uganda
		Longe 10H	Hybrids	Green belt, Hills and Mountains and Ironestone zone	Uganda
		GRENNGOLD (SC0923)	Hybrids	Green belt, Hills and Mountains and Ironestone zone	Zmbabwe
		MAXIM (SC719)	Hybrids	Green belt, Hills and Mountains and Ironestone zone	Zmbabwe
	OPVs	M45	Open Pollinated	Green belt, Hills and Mountains and Ironestone zone	Kenya/Uganda
		KDV4	Open Pollinated	Green belt, Hills and Mountains and Ironestone zone	Kenya
		Longe 4	Open Pollinated	Green belt, Hills and Mountains and Ironestone zone	Uganda
		Longe 5	Open Pollinated	Green belt, Hills and Mountains and Ironestone zone	Uganda/South Sudan

1.3	**Rice** (Uplands)	NERICA 1	Open Pollinated	Green belt and Ironestone zone	South Sudan/Uganda
		NERICA 4	Open Pollinated	Green belt and Ironestone zone	South Sudan/Uganda
		NERICA 10	Open Pollinated	Green belt and Ironestone zone	South Sudan/Uganda
		DKAP-27	Open Pollinated	Green belt and Ironestone zone	South Sudan/Mali
	Lowlands	NERICA L-1	Open Pollinated	Flood plain and Nile and Sobat River	Uganda/Ivory Coast
		NERICA L-2	Open Pollinated	Flood plain and Nile and Sobat River	Uganda/Ivory Coast
		Komboka	Open Pollinated	Flood plain and Nile and Sobat River	Uganda
		Wita 9	Open Pollinated	Flood plain and Nile and Sobat River	Uganda
		Supa 1052	Open Pollinated	Flood plain and Nile and Sobat River	Uganda/Ivory Coast
2.0	Oil crops	**Varieties**			**Potential Source**
2.1	Sesame	Sesame 1	Open Pollinated	Ironestone, flood plain, semi-dry areas and parts of green belt	Uganda
		Sesame 2	Open Pollinated	Ironestone, flood plain, semi-dry areas and parts of green belt	Uganda
2.2	Sunflower	Black /white stripped	Open Pollinated	Ironestone, flood plain, semi-dry areas and parts of green belt	Uganda/Kenya
		Black	Open Pollinated	Ironestone, flood plain, semi-dry areas and parts of green belt	Uganda/Kenya
2.3	Groundnuts	Serenut 2	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Uganda
		Serenut 4	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Uganda
		Serenut 4T	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Uganda
		Red beauty	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Uganda/South Sudan
		Sodari	Open Pollinated	Ironestone, flood plain, Arid areas, Hills	Sudan

				and mountains and Green belt	
		Berbedi	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	South Sudan
		Mr Lakes	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	South Sudan
		Manipintar	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Zambia
		MaKulu Red	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Zambia
		Agar	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Sudan
		Berit	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Sudan
		Igola	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Uganda
		YEIPA1 (SVG 99031) TAN	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Uganda/South Sudan
		YEIPA 2 (SVG 99064) RED	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Uganda/South Sudan
		YEIPA 3 (Serenut 5) RED	Open Pollinated	Ironestone, flood plain, Arid areas, Hills and mountains and Green belt	Uganda/South Sudan
3.0	Pulses	**Varieties**			**Potential Source**
3.1	Cowpeas	Secow 2W	Open Pollinated	Ironestone, flood plain, semi-dry areas and parts of green belt	Uganda
		Secow 1 T	Open Pollinated	Ironestone, flood plain, semi-dry areas and parts of green belt	Uganda
		AGRAC-116	Open Pollinated	Ironestone, flood plain, semi-dry areas and parts of green belt	South Sudan/Nigeria

		AGRAC-216	Open Pollinated	Ironestone, flood plain, semi-dry areas and parts of green belt	South Sudan/Nigeria
		AGRAC – 316 (Mabior bor)	Open Pollinated	Ironestone, flood plain, semi-dry areas and parts of green belt	South Sudan
3.3	Beans	Rosecoco	Open Pollinated	Green belt and Ironestone zone	Kenya
		K132	Open Pollinated	Green belt and Ironestone zone	Uganda
		French beans	Open Pollinated	Green belt and Ironestone zone	Kenya
		NARO bean 1	Open Pollinated	Green belt and Ironestone zone	Uganda
		NARO bean 2	Open Pollinated	Green belt and Ironestone zone	Uganda
		NABE 15	Open Pollinated	Green belt and Ironestone zone	Uganda
		NABE 17	Open Pollinated	Green belt and Ironestone zone	Uganda
3.4	Soya beans	Maksoy 1 N	Open Pollinated	Green belt and Ironestone zone	Uganda
		Maksoy 2 N	Open Pollinated	Green belt and Ironestone zone	Uganda
		Maksoy 3 N	Open Pollinated	Green belt and Ironestone zone	Uganda
		Namsoy 4N	Open Pollinated	Green belt and Ironestone zone	Uganda
4.0	Roots and Tubers	**Varieties**			**Potential Source**
4.1	Cassava	TME 14		Green belt, H&M and Ironestone	Uganda/South Sudan
		Akena		Green belt, H&M and Ironestone	Uganda
		PAYE 1 (Nase 17) SWEET		Green belt, H&M and Ironestone	Uganda
		PAYE 2 (Nase 19) SWEET		Green belt, H&M and Ironestone	Uganda
		PAYE 3 (Nase 18)		Green belt, H&M and Ironestone	Uganda
		NASE 14		Green belt, H&M and Ironestone	Uganda
		TME 14		Green belt, H&M and Ironestone	Uganda
		Movvondo		Green belt, H&M and Ironestone	South Sudan
		4271		Green belt, H&M and Ironestone	Uganda
5.0	Vegetables	**Varieties**			**Potential Source**
5.1	Amarantus	White Elma		Ironestone, flood plain, semi-dry areas	Kenya/Uganda

				and parts of green belt	
5.2	Tomatoes	Money Maker		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
		Cal J		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
5.3	Carrots	Nantes		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
5.4	Onions	Red Creole		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
		Bombay Red		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
5.5	Kales/Collards	Georgia		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
5.6	Watermelon	Crimson Sweet		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
		Charleston Grey		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
5.7	Eggplants	Black Beauty		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
5.7	Cabbage	Copenhagen		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
		Drum head		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
5.9	Okra	Clemson Spineless		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda
		Pusa Sawani		Ironestone, flood plain, semi-dry areas and parts of green belt	Kenya/Uganda

Source Ministry of Agriculture and AGRA South Sudan 2018

Annex II: Seed Distribution Pathways for ZEAT BEAD 2 and SORUDEV SSR

Background:

The European Union rural development programmes in South Sudan within the national NEAT programme of the Government of South Sudan, in the last ten years funded several food security projects (including substantial road rehabilitation) aimed at strengthening the capacity of farmers and to support both vulnerable and smallholder farmers in the rehabilitation and recovery process to also strengthen resilience. The core programmes were the FSTP, Pro-Act, SORUDEV, SORUDEV-SSR and ZEAT BEAD (1&2).

The programmes were designed and implemented grounded on the geographical context of the country based on:

A. Farmer Identification Process

1. IPs identify poor farming households using a clear selection and vulnerability criteria

They shall:

. Keep a detail farmer registration list with criteria of selection and Gender

. Keep the village, boma and payam names and coordinates

. Fill the information into the official project database www.ciissouthsudan.org

. Identify the seed type and varieties required by the farmers (to be clear with names, variety and characteristics of seeds required. Therefore to cross check this with the MoA departments of crops, crop protection and extension services at each state and county level).

B. Farmer capacity building Process

2. IPs commence capacity building training on agronomic practices

They shall:

- Start with capacity gaps in understanding and on current agronomic practices and nutrition
- Train and orient their extension and community development officers in extension methodologies (FFS, Lead farmers, Groups, etc.). Decide at this point if a demonstration field is needed and do not confuse this with FFS.
- Using this information, develop and commence training of farmers in a structured manner.

C. Seed Procurement Process

3. IPs procure improved and certified seeds for distribution to vulnerable and smallholder farmers.

They shall:

- Do a mapping of all seed companies where good quality improved and certified seeds can be purchased. This should be done ahead of time bearing in mind that it takes time to identify the seeds providers, to operate in the country and to personally verify and check references including from FAO; and then check approval of the national Ministry of Agriculture.

- Use a very clear guideline on seeds procurement that clearly lists the quality and conditions of seed purchases. QDS standards suggests that good quality cereal seeds should have about 13-15% moisture content, legumes at 10% or below and vegetable seed at 8 % or below.
- Determine the quantity of seeds required by each farmer to launch seed procurement. This can be calculated though simple multiplication; for instance, if each farmer requires 3kg of sorghum and the target number of farmers is 3000, then the quantity needed is 3x3000 = 9000Kg of seeds.
- It is very important to check the EU general conditions for procuring goods and services on PRAG. Please note the thresholds for single procedure, negotiated, advertisement in country and threshold for purchasing overseas often based on total value of the commodity. It is also very important to check the government of South Sudan regulations guiding importation, tariffs and tax exemptions.

D. Procuring foundation seeds for seed producer groups

There is a clear difference from “improved certified seeds” distributed to farmers from the “foundation seeds” that will be distributed to seed producer groups.

IP again should map sources of foundation seeds. At this point in South Sudan there are very few companies or institutes producing foundation seeds; therefore it’s not unusual to source this from neighbouring countries. In the case of Sorghum and Millet for example the Research institute in Sudan has bred Bushana and Ashana varieties of Sorghum and Millet, respectively, which could be obtained very easily. Similar varieties could be available in Uganda, Ethiopia or Kenya.

Again IPs should follow very strict guidelines for importing seeds and for moving seeds across country borders. Based on the old Sudan regulations[4] and pending the finalization of Seed Act is South Sudan this includes:

The process starts at the Seed Administration

1. Only Companies registered with Seed Administration are allowed to import crop seeds.
2. To get a preliminary import permit for the importation of seeds the registered company has to follow the following rules of procedure
3. Submit a written application on the Company’s headed paper signed and stamped, showing the following information: crop variety intended to be imported, seed class quantity, the purpose for import and the port of entry.
4. Present a pro-forma invoice from the exporting company or its branches
5. The application to import field crops should be only for the registered varieties released by the Variety Release Committee

Pay the assigned fee

- Imports of vegetable seeds are exempted from registration.
- After presenting the preliminary import permit to the Office of the Undersecretary of Agriculture and paying the assigned fee, a phytosanitary import permit (Form No 10) will be issued for the importer permitting the company to import the seeds within 45 days

E. Working with the seed producer groups

IPs shall identify existing cohesive and strong farmer groups with clear interest in producing seeds or already producing seeds for sale.

A decision should be made on the number of seeds producing groups. It should also take into account the number of farmers making up the group and whether they will have a single group farm or individual group members' farms. Understanding logistical and material situations required are equally important.

. IPs shall assess the farmers' understanding and knowledge of seed production checking if they understand the difference between "grain" and "seed".

. PIs shall conduct training on agronomic practices on the essential seed production techniques, seed processing, packaging, storing and marketing. There are publications by FAO, EUTA and many others that can be referenced.

. Seed production requires more time and it will make sense for IPs to have dedicated extension staff to work with the producer groups.

Annex III: Required Conditions for Seed Treatment in an FAO-Supported Intervention

At the seed treatment facility:

• The pesticide products applied must be cleared by FAO's Plant Production and Protection Division and must be registered with the relevant national authority in the country/countries concerned.

• The company providing the pesticides has to declare that they are observing the FAO Code of Conduct on Pesticide Management, especially its provisions on labelling, as well as packaging and transport of pesticides.

• Users of pesticides applied as seed treatment must adhere to the necessary pre-cautionary measures described on the product labels (e.g. wearing a protective mask, goggles and gloves).

• The treatment of seeds must be done in an appropriately equipped facility that ensures full containment of the pesticides.

• Users of seed treatment equipment should be provided with suitable application equipment and instructed on calibration, use and cleaning of the equipment.

• Treated seeds must be dyed an unusual and unpalatable colour to discourage consumption.

• All packages containing treated seeds must be clearly marked "Not for human or animal consumption" and with the skull and crossbones symbol for poison.

At the point of use of the treated seeds:

• Those handling treated seeds should be informed that the seeds are treated with pesticides, which can have toxic effects on their health, the health of others and on the environment.

• Handlers should be advised to wear clothes that fully cover their body (long sleeves, long trousers/skirt and closed shoes), and the distribution kits should include gloves and dust masks with instructions on their use; handlers must wash themselves and their clothes after handling the seed.

• Packaging from treated seeds should not be reused for any purpose

Annex IV: Compilation of World Vision South Sudan experience and guiding note on Quality Declared Seeds

Acknowledgement: This summary notes, figures and picture taken from Effective Seed Quality Assurance, ISSD Africa, Synthesis Paper and FAO guide on quality declared seed system (2006)

Introduction;

Quality assurance is an important aspect of seed production and marketing. Seed producers or seed traders distinguish themselves from grain producers or grain sellers by offering quality seed in response to the demands of the seed client. External quality assurance is often seen as the center piece of the seed sector, and so when aiming to strengthen seed sector functioning, the automatic response is to improve seed certification systems. It should be noted, however, that there is little evidence of well-functioning seed certification systems in sub-Saharan Africa. The system of independent seed certification is not the only option for improved quality assurance.

Alternative quality assurance mechanisms;

Internal & External quality control;

Internal quality control refers to the measures that seed producers take to ensure that the seed they produce meets their own minimum standards. Every seed producer, whether informal or formal, practices some form of internal quality control. External quality assurance refers to an independent or semi-independent form of inspection of the quality of the work done by a seed producer. External quality assurance has as such no influence on the quality itself; it only verifies whether a certain quality standard is met.

A stronger emphasis on improving internal quality control by seed producers could be made a more deliberate part of seed sector interventions. Judging from the case studies, seed producers could benefit from clear, pragmatic crop specific quality control protocols for the management of their seed crop. Such quality management protocols should not only specify norms, but they should also assist seed producers in following specific steps in crop management and administration during the production season. As a result, seed producers would be better able to monitor the quality of their seed crop, respond with specific cultural practices in a timely manner, and downgrade their seed if necessary. Better monitoring of the seed crop will also deter seed producers from inviting inspection services to check a crop that is clearly not within the norms, thus avoiding costs to the seed producer as well as to the seed certification body.

The value of external quality assurance

It has to be acknowledged that seed is often produced and traded without external quality assurance mechanisms. So it is valid to question what the added value of external quality assurance actually is. External quality assurance is first and foremost a service for seed clients, who can rely on it when judging the quality of the seed they intend to buy and use. As their own productivity depends on the quality of the seed they buy, an additional safeguard that the seed they purchase is of decent quality is appreciated by farmers.

It was also agreed that farmers would likely be willing to pay for external quality assurance under three important conditions:

- The additional cost of external quality assurance is modest compared to the profits they could obtain from the crop;
- They are convinced of the rigour of the external quality assurance; and
- There is a clear difference in the yield potential of quality seed produced by a seed producer, and their own seed.

Alternatives to classical seed certification systems

In the desk study, the African case studies and the experts' debate, a number of alternative models for certification were identified and discussed. Table 3 provides a schematic overview of different quality assurance mechanisms identified and their advantages and disadvantages as perceived

Table -1: Seed quality assurance mechanism

System	Advantage	Disadvantage	Example
Self-control	Cheap and simple; based on reputation protection	Subjective; cannot be controlled; difficult to market off-farm; little incentive to be consistent; no check on the knowledge of the local seed producer	South Sudan
Truthfully labelled	Cheap; based on reputation protection; full private sector control over logistics	Requires ethical entrepreneurs; only works where a company wants to protect its reputation; responsibility with seed buyers to make a prudent choice	State seed trade in India
Group control	Internal organization of inspection; Cheap	Not independent; sensitive to internal group politics	Burundi & Uganda
Quality Declared Seed (QDS)	Local inspection; independent; relatively cheap	often limited laboratory testing; largely field-based observations	Uganda & Tanzania
Certification	Least opportunity to cheat; fully independent	quires complex logistics; centralized laboratory testing; requires full-time inspectors	Formal System in most country

Quality declared seed

Quality declared seed (QDS) refers to a form of quality assurance that was created to reduce the burden of rigorous conventional seed certification, while retaining the basic characteristics of external quality assurance, and thereby increasing access to quality seed for smallholder farmers

The leading principle of QDS is that quality assurance is organized locally, through individual self-control or through group-based mechanisms as described above. The national seed inspection services only routinely check a random sample of seed producers to assess whether the local quality assurance mechanism is functioning properly. The standards the seed producers need to adhere to under QDS can be adapted to the local situation.

The experience of Tanzania in QDS: The main distinction from the certified seed system is that only a proportion of fields are inspected each season, and the inspection is implemented by the local agricultural officer. This reduces travel distance and thus the costs of inspection. QDS seed is marketed locally in Tanzania and is restricted to OPVs, to reduce the Competition with fully certified seed. QDS was introduced more recently in Uganda, where it is restricted to crops that were not considered to be catered for by the formal seed system using official certification, which is the case for practically all crops with the exception of maize and sunflower.

An obvious advantage of QDS compared to self-control is the introduction of a truly external quality assurance mechanism that provides a clear incentive for seed producers to be rigorous and methodical about the quality control of their seed.

Options for improving QDS;

- Institutionalization of QDS in the national seed regulations
- Development of realistic minimum quality parameters
- Development of local inspection capacity
- Development of local laboratory testing capacity & local laboratory testing protocols
- Support for local labelling and marketing of QDS seed

Maize seed produced in South Sudan under self-quality control (Picture taken from the same publication Effective Seed Quality Assurance, ISSD Africa, Synthesis Paper)

Guiding note on team composition, procedure to follow for quality declared seed and format used for evaluation.

The quality inspection team;

1.	State DG for Agriculture or his delegate	Chair person
2.	Director or inspector for agriculture - State	Member
3.	Head of County Agriculture	Member
4.	One Agronomist from Research or University	Member
5.	WV Agronomist/Manager	Member

The inspection team will do two round inspection using an objectively prepared evaluation sheet for scoring.

Round -1: At vegetative stage to see the planting techniques, crop management, ways of controlling pest and disease and rogueing of off-types (any very tall or very short or different colour exist)

Round-2: Before harvest to see the performance of the crop and sample check any pest/disease infestation, to check how the group prepared to do the sorting, transport and storage e.t.c

Other task of the inspection team,

1. Suggest the packing and labelling methods
2. Facilitate market linkage in the operational area by dealing with other FSL project implementing partner.
3. World Vision will facilitate seed expo so as to create public awareness on how the seed quality rated and declared so as to motivate farmers to given more attention to quality in the next season.
4. Assess the price of seed in the local market and project the selling price for different level of quality declared seeds

5. World Vision to contact Seed companies and NGOs at local level and national to contract the QDS seed at a high pre-arranged price. WVSS will not sign the contract but only facilitate the meeting of buyers and sellers.
6. A germination test will be conducted one month before sales to determine germination %

Seed multiplication group evaluation form

Evaluation form on the vegetative phase of growth (The rating will be in score of 1 to 5 (Very good: 5, Good: 3 & Not good: 1)

s/n	Name of the group	Crop	Planting standard (line planting & Spacing)	Isolation (Geographic or planting time)	Crop management(harrowing, weeding,	Pest & Disease control	Total Score

Evaluation form during harvest

s/n	Name of the group	Crop	Crop Management (weed control etc)	The situation of the Yield	Pest and disease control	Group plan for harvest, sorting, grading and storage	Total score

Summary sheet of field evaluation and categorizing the seeds/groups in to three levels

s/n	Levels of QDS	Description of the different levels in declaring the quality of the seed.	Farmer Groups and the type of crop in this category	Remark
1	Level -1			
2	Level -2			
3	Level-3			

Joint committee recommendation of price for different level of quality declared seed.

Group's planned to sale during harvest

s/n	Type of crop grown for seed	Market price for 1kg of seed in the area- **During harvest**	Quality Declared Seed Level Based on filed observation & evaluation			Remark
			Level-1	Level-2	Level 3	
	Sorghum					
	G/Nuts					
	Maize					
	Beans					
	Cassava					

Groups planned to sale in April adding time value with proper storage

s/n	Type of crop grown for seed	Market price for 1kg of seed in the area- **During April 2019**	Quality Declared Seed Level Based on filed observation & evaluation			Remark
			Level-1	Level-2	Level 3	
	Sorghum					
	G/Nuts					
	Maize					
	Beans					
	Cassava					

Annex V: Fall Army Worm Stages of growth in Pictures

Egg mass on lower leaf surface — Young larvae (caterpillars) in maize plant whorl

Advanced larva stage and its frass (excreta) — Typical FAW foliage damage on maize

Typical FAW damage on maize tassels

The "Y" pattern on head of Armyworm larva and 4 distinct dots on last segment

Source: Status of the Fall Army Worm (FAW) in Kenya

Annex V: FAO Emergency Farm Kits for Farmers

The Food and Agriculture Organization of the United Nation (FAO) is a major player in supporting farmers and the people of South Sudan. FAO emergency operation is critical especially during the period of emergency when government's capacity to support farmers and the large vulnerable population is often weak. This is a critical part of their mandate. Along with NGOs and CBOs partners, FAO in South Sudan has demonstrated their commitment to support farmers through the distribution of assorted seeds, tools, fishing kits often referred to as emergency livelihood kits.

The organisation's experience in supply chain management enables the procurement of seeds in the sub region and across the world. The stringent guidelines and instruction for Quality Declared Seeds which are followed for sourcing good quality seeds are referenced globally. The presence of FAO on the ground enables their staff and with partners to deliver seeds directly to farmers with the objective to either help the beneficiaries replace their lost seeds or augment the little seed stock they are left with as a result of the war, displacement or migration.

http://www.fao.org/emergencies/fao-in-action/stories/stories-detail/en/c/232311/

In each emergency kit handed to a needy farmer in South Sudan the seed component of it comprise of the following:

Crops	Variety	Quantity	
Sorghum			
Groundnuts			

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