

Seeds in Emergencies:

A technical handbook



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Acronyms and Abbreviations

CIAT	International Center for Tropical Agriculture
DNA	Deoxyribonucleic acid
FMA	Famine Mitigation Activity
GMO	Genetically Modified Organism
IP	Implementing Partner
IPPC	International Plant Protection Convention
ISTA	International Seed Testing Association
ITF	Input Trade Fair
NGO	Non-governmental Organization
OECD	Organisation for Economic Co-operation and Development
OFDA	Office of United States Foreign Disaster Assistance
OPV	Open-pollinated variety
PAGE	Polyacrylamide Gel Electrophoresis
PGRFA	Plant genetic resources for food and agriculture
QDS	Quality Declared Seeds
SV&F	Seed Vouchers and Fairs
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UTILEF	Ultrathin-layer Isoelectric Focusing

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Preface

Seeds are critical for addressing the dual challenges of food insecurity and climate change. Farmers depend on quality seed of appropriate varieties to attain food security. However, in recent times, natural disasters, such as droughts, floods and hurricanes, and human-caused disasters, such as wars and civil conflicts, have had an increasingly devastating impact on rural livelihoods and crop production systems, by halting crop production, destroying agricultural assets, hindering farmers' access to agricultural inputs and decreasing food security. Addressing the seed security of disaster-affected households, through relief operations, is a frequent response undertaken by national governments, UN organizations and NGOs to facilitate their recovery.

This publication is a step towards improving the quality and effectiveness of seed provided in emergency operations. An understanding of the major technical aspects of seed and related aspects is necessary for planning and conducting seed security assessments, as well as for providing quality seed to vulnerable households. This handbook is aimed at providing the field staff involved in such operations with the basic technical knowledge required for such operations. The handbook will assist emergency staff in identifying seed quality problems that can occur during seed relief activities and in taking appropriate action to maintain seed quality standards. Availability of practical information can increase the speed and effectiveness of seed relief operations.

The Plant Production and Protection Division of FAO is committed to assisting national authorities, Implementing Partners (IPs) and FAO emergency staff in carrying out effective seed relief operations.

Shivaji Pandey

Director, Plant Production and Protection Division, FAO

Summary

SEED QUALITY ATTRIBUTES

In seed relief operations, the **physical, physiological, phytosanitary and genetic qualities** of the seed require attention so that vulnerable farmers are provided with quality seed of the appropriate crops and their varieties.

SEED SAMPLING

To determine the quality of a shipment of seed, samples must be taken in such a way that they are representative of the entire quantity of seed ordered. The seed quality testing is performed on part of the representative sample, and therefore a technically-sound sampling methodology is very important for the validity of the seed testing results. Seed sampling should be carried out according to the international rules for seed testing, published by the International Seed Testing Association (ISTA). Seed sampling and testing are part of the seed procurement process, but may also be undertaken by local officials, Implementing Partners (IPs) and emergency staff to verify the quality of seed before delivery to farmers or to verify quality if the seed has been stored for several months.

SEED TESTING

Seed testing provides essential information for determining the quality of a shipment of seed and comprises such parameters as germination, physical purity and moisture content. This ensures that it meets the technical specifications of the order and that quality seed is being provided to vulnerable farmers. Seed testing should be carried out in a national seed laboratory or ISTA-accredited laboratory.

QUALITY DECLARED SEED (QDS)

Seed for emergency operations should comply with quality standards to ensure that quality seed is provided to vulnerable farmers. The Quality Declared Seed (QDS) scheme, developed by FAO, provides seed quality standards that are used as minimum standards for seed purchased in seed relief activities (cf. Annex 3).

VARIETY TYPE

Self- and open-pollinated varieties are preferred for emergency operations because farmers can save the seed from the harvest to plant in the following

season. In general, it is not recommended to distribute hybrid varieties in such operations.

SEED DETERIORATION

Temperature and relative humidity of the storage environment are two critical factors that require careful attention for an environment favourable for seed storage. The lower the temperature and relative humidity, the longer the seeds can be safely stored. The moisture content of the seed and the particular crop are also important factors in seed storage. Therefore, in emergency operations, seeds should not be stored for extended periods in tropical conditions in order to avoid problems with seed deterioration resulting from high temperatures and relative humidity.

SEED STORAGE

Effective seed storage requires: the seed to be dried to the prescribed moisture content; a clean, well-ventilated storage area, and if needed, treatment of the seed to prevent insect attack; and periodic inspection of the stored seed. Seed should not be stored for extended periods under conditions of high temperatures and relative humidity.

TECHNICAL ASPECTS OF SEED PROCUREMENT

Local procurement: It is recommended to work with local authorities to identify the adapted local varieties, obtain their varietal descriptions, and ensure that the seed meets or exceeds QDS standards and follows local procurement guidelines.

Technical aspects of market-based approaches to emergency seed provision: Market-based approaches, including seed fairs, are raising a great deal of interest because they offer farmers a choice of seed and other inputs they receive and because they create links between beneficiaries and local seed systems, both formal and informal. It is important, however, to put measures in place so that the right varieties are available and to ensure quality of the seed offered to farmers during seed fairs.

International procurement: As with local procurement, varieties need to be identified and approved by competent and recognized local authorities together with the provision of their varietal descriptions. Technical specifications for seed should meet or exceed QDS standards.

ISTA Orange Certificate: This certificate verifies that an ISTA-accredited laboratory technician collected a representative seed sample on which the seed tests were performed. These certificates are requested by FAO in the international procurement of seed.

SEED IMPORT REGULATIONS

Import regulations attempt to safeguard a country against the introduction of new pests, diseases and weeds that may be contained in seed imports.

Phytosanitary certificate: This is almost always required for imported seed to ensure that it does not contain a pest or disease that could be harmful to the country. The certificate is established by the country of origin of the seed, taking into account the quarantine pest list of the recipient country.

Import permit: Certain crops require an import permit, so it is advisable to check with government officials before importing seed.

Post-entry quarantine: The imported seed can be held in quarantine at the point of arrival in the country if post-entry quarantine is deemed necessary by the plant quarantine officials.

VEGETATIVE PLANTING MATERIAL

There is an increasing interest in the need to provide vegetatively-propagated planting material to farmers in seed relief operations. A primary concern about using these materials in emergency operations is that pests and diseases might be present on or in the living tissue of vegetative planting material and can be transmitted when transported to other areas, where they can potentially infect not only the crop, but other species as well. For this reason, particular care needs to be taken in the production of vegetative planting material to remove pest- or disease-infested plants. In addition, fields and planting material need to be inspected periodically by qualified staff, particularly at the time of harvesting the material for distribution in emergency operations.

1. Introduction

Basic knowledge of the technical aspects of seed is important for planning and conducting seed assessment and seed relief. Although agronomists involved in such exercises are familiar with some of these technical dimensions, other staff playing equally important roles often have limited expertise in this subject. Understanding the technical terms and concepts involved in the seed relief operations will increase their speed and effectiveness. In addition, the ability to deal with seed quality problems that can occur during seed relief activities (see Annex 5, Glossary) will ensure that the correct procedures for the verification and maintenance of seed quality standards are being followed. The Plant Production and Protection Division of FAO is committed to assisting national authorities, IPs and emergency staff in carrying out effective seed relief operations. This publication is one of the initiatives towards fulfilling this commitment.

2. Seed quality attributes

One of the primary strategies of FAO in emergency operations is the provision of quality seed of appropriate crops and varieties to farmers in a timely manner so as to increase their seed security and food security. It is essential that project implementers have an understanding of the technical and operational aspects of seed quality to carry out this strategy. Quality seed is critical to agricultural production: poor seed limits the potential yield and reduces the productivity of the farmer's labour. There are four basic parameters for seed quality attributes:

- physical qualities of the seed in the specific seed lot;¹
- physiological qualities, which refer to aspects of performance of the seed;
- genetic quality, which relates to specific genetic characteristics of seed variety;
- seed health, which refers to the presence or absence of diseases and pests within a seed lot.

When seed has good physical, physiological, seed health and genetic qualities, farmers have greater prospects of producing a healthy crop with improved yields. High quality seed is a major factor in obtaining a good crop stand and rapid plant development even under adverse conditions, although other factors such as rainfall, agronomic practices, soil fertility and pest control are also crucial.

It is essential in seed relief operations to deliver an appropriate crop variety and good quality seed to farmers at the right time to improve their food security, **rather than unknowingly contribute to food insecurity by providing poor quality seed**. One of the ways in which attention has been paid to the seed quality issue by relief organizations is by insisting on germination and seed purity tests provided by seed suppliers. However, these initial tests may not be sufficient to guarantee that the seed is of good quality when it reaches the farmer. Delays in seed delivery and how the seed is stored (in transit and at the users' end) can have dramatic negative effects on the seed. For this reason, it may also be necessary to verify the quality of the seed immediately before it is delivered to farmers.

¹ **Seed lot** - an identifiable quantity of seed of one variety, of known origin and history, and controlled under one reference number in a seed quality assurance scheme.

2.1 SEED QUALITY ATTRIBUTES - PHYSICAL

Physical qualities of the seed in a seed lot are characterized by having the following:

- **A minimum of damaged seed:** damaged (broken, cracked or shrivelled) seed may not germinate and is more likely to be attacked by insects or micro-organisms. It is possible to eliminate most of the damaged seed during seed processing (conditioning).
- **A minimal amount of weed seed or inert matter:** good quality seed should be free of weed seeds (particularly noxious types), chaff, stones, dirt and seed of other crops. Almost all these impurities can be discarded during processing/conditioning.
- **A minimum of diseased seed:** discoloured or stained seed are symptoms of seed that may carry micro-organisms that have already attacked the seed or will attack it when it starts to grow. The plant may live and spread the disease to other plants.
- **Near uniform seed size:** mature medium and large seed will generally have higher germination and vigour than small and immature seed. In the conditioning (processing) of a seed lot, undersized and light seeds are normally eliminated.

Physical quality parameters such as seed uniformity, extent of inert material content and discoloured seed can be detected by visually examining seed samples.



Farmers cleaning bean seed in Haiti

material content and discoloured seed can be detected by visually examining seed samples. **Closely examining handfuls of seed is the first step for a better understanding of the quality of seed** provided to farmers; it gives the first but not the only opportunity to decide on seed cleaning needs.

2.2 SEED QUALITY ATTRIBUTES - PHYSIOLOGICAL

- **High germination and vigour:** The germination percentage is an indicator of the seed's ability to emerge from the soil to produce a plant in the field under normal conditions. Seed vigour is its capacity to emerge from the soil and survive under potentially stressful field conditions and to grow rapidly under favourable conditions. The loss of a seed's ability to germinate is the last step (not the first step) in a long process of deterioration (gradual loss of viability). Decrease in seed vigour and other physiological changes occurs before loss of germination. Therefore, seed with acceptable germination can be low in vigour.

The importance of physiological quality cannot be overemphasized. Seed can only fulfil its biological role if it is viable. Therefore, physically uniform seed of an adapted variety will be useless if it is low in germination and vigour, or if it fails to germinate when planted. **The difference between grain and seed is that the former may or may not germinate, while the latter must germinate.** This is why germination, particularly a high percentage of it, is such an important technical specification for seed.

2.3 SEED QUALITY ATTRIBUTES - GENETIC

- **Seed of the same variety:** Within crops species such as maize, rice or groundnuts, there are thousands of distinct kinds of each crop, which are referred to as “**varieties**” or “**cultivars**”. Plants produced by seeds of a variety present the same characteristics, which are reproducible from one generation to another. The definition of a cultivar is an assemblage of cultivated plants that can be clearly distinguished by any characteristics (morphological, physiological, cytological, chemical or others) and which, when reproduced (sexually or asexually), retains its distinguishing characteristics.
- There are **improved varieties** that are the result of plant breeding and varietal development programmes, multi-location trials, national variety release systems and formal seed production systems (Annex 5). Other kinds of crop varieties are **traditional varieties (also known as landraces)** that are produced and conserved by farmers. They can be a local population of plants selected by farmers or are sometimes improved varieties that were released many years ago. Seed of different varieties of the same crop is often difficult or impossible to distinguish once harvested. Mixing of different varieties of the same crop or species can occur when the grain/seed is sold and enters the formal and informal marketing system. Mixture of varieties may mature at different times, which can lead to problems in harvesting and post-harvest handling, and results in lower yields. Additionally, each seed of an undesired variety

in a mixture will produce seed when it is planted, which will in turn produce more seed so that each year the proportion of the undesired variety becomes greater. Field inspection followed by roguing (removal of undesirable plants) during the growing period of the seed crop is one of the steps taken to optimize varietal purity. However, it must be pointed out that traditional varieties or landraces, particularly of cross-pollinated varieties used by subsistence farmers, are often populations of plants that are not very uniform. This heterogeneous character can be an advantage in some circumstances, such as low rainfall, low fertility, and pest and disease pressure. For example, in Burundi, farmers prefer to plant bean seeds that are a mixture of bean varieties.

- **Adapted to the local conditions:** The length (days) of the growth cycle is a critical characteristic in particular for rainfed crops to enable them



Technicians observing panicles of different rice varieties

to mature while there is sufficient moisture for grain filling. Adaptation to soil, soil fertility, diseases, pests, day length and moisture regimes are all important characteristics of a crop variety.

Plants will grow well and produce an abundance of seed only in the proper environment. It is difficult to anticipate how a variety

will respond to a different agro-ecological zone until it is actually grown there. Therefore, variety trials are important since they establish the recommended zones of adaptability for varieties. In drought conditions, although farmers may be interested in earlier maturing varieties, this is not always the best option. For example, bird attacks on the maturing grain of these varieties (rather than the conventional, longer duration variety) can be severe and discourage farmers from planting them. However, when early maturing varieties must be grown, there are certain varieties of some crops that are tolerant to bird damage which minimizes the effect of this pest, e.g. in rice and sorghum. For these varieties, it is also possible to delay the planting so that the maturity of the crops corresponds with later matur-

ing varieties in order to diffuse bird damage over all the crops of the area. It is also important to note that crop adaptation has a limit; it is wrong to believe that a variety can do well under all growing conditions. This should be kept in mind as we propose new varieties to farmers during emergency operations.

- **Proper characteristics for use:** A crop must have the right organoleptic properties: these refer to the processing, cooking, colour and taste characteristics that are compatible with local preferences. Farmers have rejected many new varieties because of poor taste or cooking and processing factors. In addition, aspects other than the edible grain may be important as the plant may be used for other purposes after harvest, such as the stalks for building material or fodder. Also, the choice of variety should take into consideration the crop architecture suited to local agronomic practices, particularly harvesting. For example, otherwise good dwarf varieties have been rejected because of the back-breaking nature of harvesting these, especially when the farmer's holding is large and there is no machine power available
- **Pest and disease tolerance:** Tolerance to pests and diseases (biotic factors) means that a plant can live with these organisms without significant loss of yield and quality. Obviously, tolerance to major diseases and pests is extremely important and a major objective of plant breeders. Disease and pest resistance are defined as absolute resistance to damage by the organisms. Tolerance and resistance can break down with time owing to mutations in the parasites or hosts. New sources of resistance and tolerance are always being sought by plant breeders. It is important to obtain precise information on disease and pest tolerance of a variety when considering the introduction of new crops and varieties.
- **High yielding ability:** This is linked to a range of plant characteristics, including plant architecture, nutrient-use efficiency, and factors mentioned above, i.e. adaptation to local conditions and pest and disease tolerance. Higher yields mean more food and income for farmers. With resource-poor farmers, it is important that high yields be achieved under low input conditions (minimal or no fertilizer and pesticides), or with the use of organic or mineral soil amendments. **However, untested new crop varieties should not be provided to farmers in emergency operations.** Observing good farming practices in terms of land preparation, sowing time, weeding, soil fertility management and water management, and avoiding post-harvest loss are important contributing factors for high yields.

2.4 SEED QUALITY ATTRIBUTES - SEED HEALTH

Seed health refers to the presence or absence of disease-causing organisms, such as fungi, bacteria and viruses, as well as animal pests, including nematodes and insects. Seed health testing can be carried out in seed laboratories in order to assess seed sanitary quality.

Ensuring seed health is important because:

- the diseases initially present in the seed may give rise to progressive disease development in the field and reduce the commercial value of the crop;
- imported seed lots may introduce diseases or pests into regions where they were not present.

The best way to avoid seed contamination by pests and diseases is to use proper seed production practices, i.e. to control pests and diseases during the seed production process. However, if a seed becomes infested with insects, then it can be fumigated. Some seed-borne diseases can be controlled or suppressed by the seed treatment during seed processing or just prior to planting. The use of seed treatment products is highly regulated at national and international levels and must be managed carefully. Special precautions need to be taken when treated seed is distributed to farmers.

3. Seed Sampling

Accurate seed testing to determine seed quality attributes such as germination and purity are based on seed samples taken from bulk quantities of seed or bagged seed organized into seed lots. As the results of seed quality tests are only reliable if the tests are carried out on a representative sample of the seed lot, sampling must be carried out using prescribed systematic sampling techniques. Procedures and techniques must be followed to ensure that the seed samples are representative of the entire seed lot and provide accurate information used in evaluation. ISTA has established regulations and procedures for sampling seed.

Seed sampling and testing is part of the seed procurement process, but it may also be used by local officials, IPs and emergency staff to verify the quality of seed before delivery to farmers or if the seed has been stored for several months.

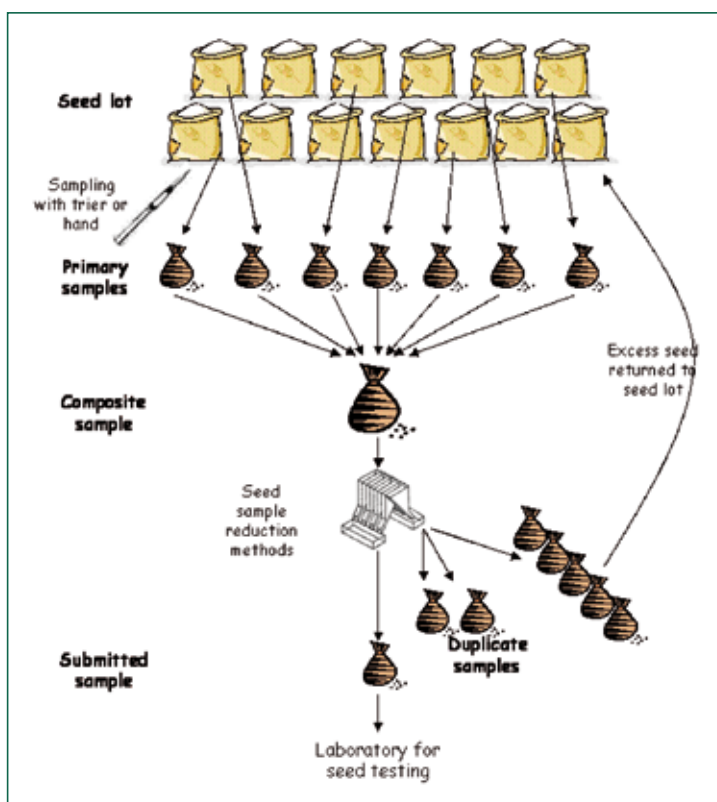
Seed testing is based on seed lots, which consist of specified quantities of seed. These seed lots should be uniform and should have been harvested from a specific seed field so that the result of future analysis can be related to that particular seed field. A seed lot consists of a number of seed containers, the nature of which can vary (bag, box, etc.). The maximum size of seed lots is actually based on the size of the seed. In general, the greater the size of the seed, the larger will be the seed lot. According to ISTA rules, the maximum lot sizes should comply with the following general pattern:

Species or type of species	Maximum size of seed lot (kg)
Maize	40 000
Cereal seed and seed larger than cereal seed	30 000
Seed of the same size as (but other than) cereal seed	20 000
Seed smaller than cereal seed	10 000

In the seed industry, seed lots are assumed to be reasonably uniform, i.e. homogenous rather than heterogeneous. For seed used in seed relief, our experience indicates that it is difficult to make this assumption. Therefore, the importance of sufficient sampling to obtain a representative sample cannot be overemphasized.

In sampling a seed lot, a sequential method is used:

- a. **Primary samples** are taken from either different containers (bags) or different locations if the seed is in bulk.
- b. Primary samples are combined and mixed to form a **composite sample**.
- c. Normally, the composite sample is thoroughly mixed and mechanically divided in a sequential manner to obtain the size of the **submitted sample** recommended by ISTA. If the composite sample is small but meets the required weight of the submitted sample, it may be used as such. The submitted sample is the one from which the **working sample** is derived for testing and evaluation.



The sampling process

cation from which samples were taken. In this way, if a problem occurs, it can be traced back to its origin and a retest submitted. Uniform quantities should be taken from the bags or containers for representative samples.

Seed inspectors and seed producers use sampling instruments called triers, or probes, for obtaining the primary samples. Triers are thin, hollow tubes that are pointed at one end, and come in a variety of sizes or lengths and with the inside partitioned or non-partitioned. The trier should be long

Obtaining a representative sample of a seed lot is as important as the seed testing itself and should be treated as a significant part of the overall testing procedure. Inert material might have been added to increase weight or broken and damaged seed might have been placed in bags at the bottom of seed stacks. Affixing or attaching relevant labels to seed sampling containers, small sacks, plastic bags or tins is necessary to identify the lot or the lo-

enough to reach the other side of the bag. When a small sleeve-type trier is inserted into a bag² of seed, the knob on the top is turned and slowly agitated while withdrawing it from the bag; it allows seed to flow along its entire length to enter through a small opening resulting in an excellent representative sample from the bag or bulk seed. With seed packaged in paper bags, the trier makes a small hole that can be sealed with tape. With some kinds of burlap or jute bags, the holes made by the trier can be closed by stroking the area of the bag around the hole to pull the fibres of the bag together, thereby closing the holes. Alternatively, and with some types of seeds (not all crops), samples can also be obtained by opening the bag and grabbing handfuls of seed preferably at the top, middle and bottom sections of the bag in a prescribed manner.

The positions in the seed lot from which the primary samples are taken may be selected at random or according to a systematic plan. Such a plan must ensure that all parts of the seed lot that may be of different quality are represented appropriately in the composite sample. For example, a systematic plan could be to sample every tenth bag.

ISTA provides guidelines for the intensity of sampling, i.e. the number of primary samples that must be drawn from the seed lot in order to establish the submitted sample. The sampling method depends on the weight of the individual containers of the seed lot:

- Seed lots in containers weighing between 15 to 100 kg - the minimum number of primary samples depends on the number of containers:

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

- Seed lots in containers weighing over 100 kg: the minimum number of primary samples depends on the size of the seed lot:

Lot size (kg)	Number of primary samples to be drawn
up to 500	At least five primary samples
500-3 000	One primary sample for each 300 kg, but not less than 5
3 001-20 000	One primary sample for each 500 kg, but not less than 10
20 001 and more	One primary sample for each 700 kg, but not less than 40.

² The trier is normally inserted at an angle of about 45 degrees to the lower horizontal point of entry to facilitate the flow of seed.

- Seed lots in containers weighing less than 15 kg.

For seed lots in containers weighing less than 15 kg, containers must be combined, in a theoretical way, to sampling units not exceeding 100 kg. Sampling units should be then regarded as containers of between 15 and 100 kg. The following formula allows the calculation of the number of sampling units in a seed lot:

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

For example, if a seed lot consists of 10 000 bags of 0.5 kg of seeds, 50 sampling units of 100 kg can be combined from them. According to the sampling method used for containers weighing between 15 to 100 kg, 20 primary samples of the seed lot must then be taken in total.

The composite sample, obtained by combining the primary samples taken from different parts of the seed lot, is often too large to be sent directly to the laboratory and has to be reduced to give the submitted sample. Specific reduction methods have been established so as not to introduce other sources of variation into the results. Specific methods for the division of seeds are described in the ISTA rules; they can be either mechanical, implying the use of dividers, or manual.

The minimum sizes of a submitted sample, according to ISTA guidelines, are as follows:

- Maize: 1 000 g
- Millet: 150 g
- Rice: 700 g
- Sorghum, wheat, barley: 1 000 g
- Groundnuts: 1 000 g
- Beans: 1 000 g
- Onion: 50 g
- Tomato: 15 g
- Okra: 1 000 g
- Eggplant: 150 g
- Other vegetables: sample size varies greatly because of a range of seed sizes. Refer to ISTA rules for details.

The importance of obtaining a representative sample from which the seed is obtained to carry out seed quality testing cannot be overemphasized, which is why the use of a technically sound sampling methodology is so important.

4. Seed testing

Procedures and standards for conducting seed testing for most crops are established by ISTA; they are periodically updated in light of new scientific evidence. ISTA does not establish the quality standards for the seed, but only the procedure for testing seed quality. ISTA also provides accreditation to seed testing laboratories, which are then able to issue the Orange Certificate, which is so important in international seed trade.

Seed testing is necessary for a number of reasons:

- to determine the quality of the seed based on a number of seed quality attributes;
- to provide a basis for price and consumer discrimination among seed lots and seed sources;
- to determine the source of a seed problem, thereby facilitating any corrective measure(s) that may be required;
- to fulfil legal and regulatory requirements for certified seed classes and allow for seed movement across international boundaries.

Four tests are routinely conducted in seed testing laboratories:

- **Physical purity:** a test to determine the percentage of the pure seed, other crop seed, weed seed, damaged seed and inert matter in the seed sample. This is also referred to as **analytical purity:** the overall percentage of the seed that is of the same crop species but not necessarily the same crop variety.
- **Incidence of noxious weed seed:** an extension of the purity test to determine the rate of occurrence of certain weed seed (as designated by law or official regulations).
- **Germination:** a test to measure the ability of the seeds to germinate and that can develop into normal seedlings, under appropriate conditions of optimum moisture, temperature, and light. Abnormal seedlings lack a shoot or root, or have other malformations.



Germination test

- **Moisture content:** there is a direct relationship between moisture content and deterioration rates, storability, susceptibility to mechanical damage, insect infestation level and fungi attack.

The following are a few examples of other seed tests that can provide additional information for evaluating seed:

- **Varietal purity:** the percentage of the pure seed that will produce plants which exhibit the characteristics of that specific crop variety. The best time to determine varietal purity is during field inspection when the seed is being produced. If a **variety verification trial** is requested then samples of the seed are compared with a reference sample of the variety in plots located alongside each other. Observations are conducted throughout the growth cycle to confirm that the seed is of the specific crop variety. For some crops and crop varieties, biochemical methods or DNA fingerprinting can be used to assess varietal purity, although they are not as yet widely accepted as a regulatory tool. ISTA has already recommended Polyacrylamide Gel Electrophoresis (PAGE) as the standard reference method for the verification of varieties of *Avena sativa*, *Pisum*, *Lolium*, *Triticum* and *Hordeum* and Ultrathin-layer Isoelectric Focusing (UTILEF) for the measurement of hybrid purity and verification of varieties of *Zea mays* and *Helianthus annuus*.
- **Seed-borne diseases:** standard principles and procedures are used by mycologists and phytopathologists to determine the presence of seed-borne diseases.

Emergency staff dealing with procurement issues when interacting with seed suppliers, national authorities' staff and seed testing laboratories, should have knowledge of seed testing procedures (Annex 2). These procedures could also be used in the field so that emergency staff can conduct seed tests themselves.

5. Quality declared seed

Various quality assurance procedures have been established for determining quality standards for seed, based on the seed quality attributes, previously mentioned. As part of their seed legislation, countries establish regulations that include the quality standard for certified seed. At an international level, the Organisation for Economic Co-operation and Development (OECD) established seed quality assurance processes and standards for countries that want to produce and sell seed internationally. In addition, some regional organizations have established seed standards for trade among their member countries. Most countries stipulate quality standards for the importation of seed.

FAO and its member countries have developed a system of quality assurance, the Quality Declared Seeds (QDS), which is not as rigorous as the OECD seed certification procedures. The purpose of QDS is to have a realistic quality assurance process and standards for seeds in countries that are at the initial stages of seed industry development. It also provides standards for crops that do not feature prominently in international seed trade despite the importance of these crops for food security in less developed countries. FAO insists that seeds used in seed relief activities should at least meet and hopefully exceed QDS standards (Annex 3). IPs and emergency staff should also be aware that some countries have specific quality standards for seed distributed in emergency situations, which can be higher than those of QDS.



Farmer in his wheat seed production field in Ethiopia

6. Variety type and seed production

A significant technical aspect of seed production relates to the way a particular crop is pollinated and whether it is self-pollinated or cross-pollinated. Basically, in **self-pollinated crops**, the male (stamen) and female (stigma) parts of the flower are very close together in the same flower, and by reason of physiological factors, such as the timing of the release of the pollen in relation to the receptiveness of the stigma, the plant will be self-pollinated. The result is that varieties of these crops are often more homogenous, because they are not likely to be pollinated by pollen from other plants of the same variety or even from other varieties of the same crop in the next field or hundreds of metres away. This also implies that seed production of these crops is easier and requires less isolation from other cultivars of the same species to ensure that the seed will be homogenous. Examples of self-pollinated crops are rice, wheat, beans and tomatoes.

Cross-pollinated crops are characterized by plants in which self-pollination is prevented by either mechanical, biological or other obstructions. Sometimes there are separate male and female flowers. In other crops, the pollen is released before or after the stigma becomes receptive on that plant. In this case, wind and insects are often important for pollination. It also means that there can be considerable cross-pollination among different fields of the same crop, even up to a distance of half a kilometre or more. Insects can cross-pollinate crops at even greater distances. As a result, these crops have the potential to be more heterogeneous and require large isolation distances from other crops of the same species to produce seed that is varietally pure. Through selection of plants for seed at harvest, farmers can maintain a degree of control over the next generation of seed. Examples of cross-pollinated crops are maize and cucumbers. Some crop species can have both types of pollination simultaneously; for example, millet and sorghum, which are mainly self-pollinated, have an out-crossing rate of between 5-20 percent.



Male flowers of maize—producing pollen that will generally pollinate female flowers of other plants of maize. The resulting cob will carry seed of a hybrid of the two plants.

Hybrids are produced by the cross-pollination of unlike parents of the same crop. In very simple terms, parent plants are selected for certain traits and are self-pollinated for several generations to produce “inbred lines”. These inbred lines are then cross-pollinated to produce the F1 generation, which is known as a hybrid. Because the parents are genetically dif-

ferent, the F1 will have “hybrid vigour” (the opposite of consanguinity), resulting in strong, vigorous plants and greater yield under good agronomic conditions. F1 plants are uniform. However, when an F1 plant is cross-pollinated with another F1 plant to produce an F2, the latter will not have the same characteristics as its parent plants; it will not have hybrid vigour, and in fact, it may grow very poorly and have low levels of vigour and yield. Herein lies the problem with the use of hybrids in seed relief operations. Traditional farming practices often rely on farmers producing and saving seed for planting in the following season. Seeds produced from a hybrid seed should not be used as seed for the next season.

Open-pollinated varieties (OPVs) are those that have been generated from populations where all plants have had an equal chance of pollinating each other and themselves. The main characteristic of these varieties is that they maintain a high degree of stability for several generations. This means that seed of OPVs can be saved by farmers for use over the following seasons and the characteristics of the varieties will remain stable. Seed production of OPVs mainly requires that isolation distances are respected, but it does not require the use of sophisticated pollination control methodologies and is therefore much simpler than hybrid seed production. Seed of hybrid varieties is generally much more expensive than that of open-pollinated varieties. Therefore, **in emergency operations, for cross-pollinated crops, it is advisable to provide farmers with OPV seed and not hybrid seed.**

In exceptional cases of seed relief in areas where farmers commonly plant hybrids, it may be possible to justify the provision of hybrids. However, hybrids generally require higher levels of inputs, especially fertilizers, in order to perform well in the field. Therefore, if hybrids are to be distributed, it is recommended to provide them together with adequate fertilizers.

Under no circumstances should seed from the harvest of hybrid crops be saved for future planting.

7. Seed deterioration

One of the important issues that emergency staff have to deal with relates to loss of seed vigour, and eventually viability, as a result of a high rate of deterioration of seed in hot, humid conditions. Problems can occur when there are delays and seed must be stored under these conditions before or after their final delivery to farmers. The rate of seed deterioration is determined by a number of factors, as explained below. There are many physiological steps in the process of seed deterioration. Seed vigour is affected early in the deterioration process. It could be described as the ability of the seed to germinate rapidly and develop into a seedling in a wide range of environments. A vigorous seed is then one that has not undergone significant deterioration. Deterioration means the loss of some key physiological functions, which can ultimately lead to loss of essential seed quality attributes such as vigour and germinating ability.

The rate of deterioration varies among crop types. Starchy seeds, for instance those of cereals, generally have a slower rate of deterioration compared to those of legumes, which are oily and have a high protein content, when all other factors such as temperature, humidity and moisture content of the seed, are the same. For example, many legumes that are high in oil content, such as groundnut and soybean, show a higher and more rapid rate of deterioration. Other legumes that are lower in oil content, such as beans or cowpeas, do not deteriorate as rapidly. Maize and millet deteriorate at a slower rate than legumes; rice has a very slow rate of deterioration in storage. There are also differences in deterioration rates among varieties of the same species.

Seed moisture content and deterioration: The moisture content of the seed is the most critical factor affecting the rate of deterioration. The optimum moisture percentage depends on the species and the temperature. As indicated in the QDS standards, cereals should have moisture content at 13 percent or below, legumes at 10 percent or below and vegetable seed at 8 percent or below (cf. annex 3). However, some legumes' seed can be easily damaged if the seed is too dry. The lower the seed moisture percentage, the slower is the rate of seed respiration. A slower rate of seed respiration results in a slower rate of deterioration. Therefore, proper drying of the seed is critical for minimizing deterioration during storage. As a rule of thumb, it may be noted that a 1 percent decrease in seed moisture content doubles the storage life of the seed.

Seed and storability: In the course of seed production, seed moisture content is initially reduced during the natural process of the seed drying on the plant before harvest. The level of seed moisture content is one of the key factors that determines when farmers can start harvesting the crop. After harvest, the seed can be further dried by spreading it on drying floors with exposure to the sun. Seed can also be dried in specially designed seed driers. Particular attention is given to seed moisture content after harvest to ensure that seed can be handled, stored and processed so that it retains high germination attributes. Seed is hygroscopic: it will absorb moisture from the surrounding air or release moisture into the air, depending on the moisture content of the seed and the air's temperature and relative humidity. After the initial drying and during storage, the seed can absorb moisture from the air or release moisture into the air until it comes into equilibrium with the relative humidity of the air. The term *seed equilibrium moisture content* is used to express the percentage of moisture in a seed at a particular temperature and relative humidity. If the relative humidity is high, then the seed moisture content will be high and the seed will rapidly deteriorate. However, when dry seed is kept in containers that allow free movement of moisture, in climates such as those of the Sahel with low relative humidity during the storage period, the seed will remain at low-moisture content, a factor for good seed storage. Conversely, in tropical climates with high relative humidity during storage, problems can develop. The seed moisture content can increase, which will increase the respiration rate and the deterioration rate of the seed. High seed moisture content is also favourable for insect infestation and growth of micro-organisms/fungi. **Moisture testers in laboratories or portable moisture testers can be used to verify the moisture percentage of seed when it is purchased and during storage.**

Special precautions are needed for extended seed storage under conditions of high temperature and high humidity. Seed companies store seed in refrigerated storerooms to protect valuable seed from deterioration until it is needed. It is important to note that at high relative humidity and temperature, seed reaches very high equilibrium moisture content. This high seed moisture content results in high rates of deterioration and loss of seed vigour and germination, particularly if it is stored before distribution. This is why there are specific guidelines for moisture content of seed for emergencies and it is recommended that seed should be delivered to farmers without delay.

High moisture content/temperature and seed deterioration: High moisture content combined with high temperatures are important factors in storage because higher temperatures increase the rate of seed respiration and seed deterioration. Sufficiently dry seed can withstand relatively high

temperatures without significant deterioration. In fact, the rule of thumb for temperature during storage is that with every 5 °C reduction in storage temperature, the storage life of the seed is doubled.

In conclusion, temperature and relative humidity of the storage environment are two critical factors that require careful attention for favourable seed storage. The lower the temperature and relative humidity, the longer the seeds can be safely stored. The moisture content of the seed and the particular crop are also important factors in seed storage. Therefore, in emergency operations, sufficiently dried seeds should be purchased and seed should not be stored for extended periods in tropical conditions so as to avoid problems with seed deterioration resulting from high temperatures and relative humidity.

8. Seed storage

Preparing for successful seed storage should begin with seed handling during harvesting and post-harvest handling prior to storage. The key steps for correct seed handling before storage are as follows:

- Minimize insect infestation in the field by timely harvesting and removal of seed from the field. This is particularly true with legumes that are prone to weevil attack in the field.
- Eliminate insect-infested seed before storage; this will effectively remove sources of future infestation or contamination.
- Dry the seed sufficiently to prevent micro-organism and insect growth, and reduce the respiration rate of the seed.
- Treat the seed with a suitable traditional or chemical insecticide to control insect infestation. In a warehouse situation, fumigation with gas is done periodically.
- Select an appropriate method of storage and environment for the seed type and size as well as for the duration of seed storage.

Storage insects are a major threat to stored seed in most countries. There are two classes of these insects: primary feeders that can attack the whole seed, and secondary feeders that can only attack damaged seed. Most storage insects are small and require close observation for detection. The essential factors for the control of storage insects are:

- Several insects attack the seed while it is drying in the field and then the insects or insect larvae remain on or in the seed when it is stored and continue to feed and multiply; prompt removal of the seed from the field is crucial to minimize initial infestation.
- Proper drying of seed to low moisture content has a negative effect on biological activities of many insects.
- Sanitation of the storage containers, such as bags or barrels, and of the storage structure, is important so that insects or larvae are removed prior to storage of newly-harvested seed.
- Seed should be treated with organic (ash, natural compounds) or by chemical means after harvest to reduce losses during storage.

Rodents are best deterred by a well organized and clean storage area: rodent-proof storage denies them a place to live or hide and denies them access to the seed.

Micro-organisms, particularly fungi, can attack if the moisture content of the seed is high as a result of poor drying or high relative humidity. Sufficiently dry seed is less affected by fungi.

Stored seed should be inspected on a regular basis to detect and correct problems. The following should be carried out periodically:

- Inspect the outside of the building for drainage or erosion problems, signs of rodent paths and holes, and the presence of household or other waste or weeds, which should be removed from around the building in order to deny entry to rodents and insects.
- Inspect the inside of the building for moisture, such as leaks in the roof, dampness on the floor, or water stains on the walls. Take note of signs of rodent activity: places of entry, faeces, damage and places where they can hide. Observe insect activity in/on the floors, walls, bags or in the air, and cracks where insects can penetrate. Note any musty odours that suggest a mould problem.
- Keep bags containing seed off the floor - moisture can migrate from the floor into the bag and can affect seed moisture content, seed deterioration rates and seed germination. Bags should be laid on pallets or on tree branches placed in a lattice formation on the floor.
- Inspect the seed inside the bags or storage container for insects or moisture.



Seed must be stored properly to limit seed deterioration. Here, seeds are stored on pallets to prevent humidity from migrating in the bags.

- If you detect problems, take immediate action to avoid the loss of valuable seed.

Seed purchased for emergency operations should be received and distributed without delay. Storing seed for prolonged periods of time (more than a few months) should be avoided. If seed must be stored for long periods, there will be a need to ensure proper relative

humidity and temperature of the storage facility, and to monitor the condition of the seed through periodic storage inspections.

Vegetable seeds stored for prolonged periods should be kept in hermetically sealed containers or sealed plastic containers. Otherwise, one can assume that the seed will rapidly deteriorate.

Hermetically sealed storage: This important storage method is often used for high value seed such as vegetable seed. Here, the seeds are dried to low moisture content (8 percent) and sealed in moisture-proof packets or tins that safeguard them from migration of moisture and air. However, if the seed is not sufficiently dry and the temperature is high, the seed will reach the equilibrium moisture content with the available air in the container, seed respiration will increase, and moisture will form inside the sealed container - this will be an ideal environment for the development of fungi and further deterioration of the seed. For this reason, in emergency operations, cereal seed of high moisture content in 5-kg sealed plastic bags can be a concern when stored for extended periods at high temperatures.

9. Technical aspects of seed procurement

Emergency interventions involving seed should be based on an assessment of the overall livelihood status of the affected populations. If the assessment indicates a problem related to seed security, then the appropriate strategy to address the problem can be implemented.

Seed security has been defined as “access by farming households (men and women) to adequate quantities of good quality seed and planting materials of adapted crop varieties at all times both good and bad.”³ In the last decade, a better understanding of seed security has been developed. A fundamental shift in thinking has resulted from the seed security framework,⁴ which is based largely on the food security framework developed by USAID in 1995 and provides insight into the parameters of seed security: availability, access and quality or suitability (see below).

Parameter	Seed Security
Availability	Sufficient quantity of seed of adapted crops are within reasonable proximity (spatial availability), and in time for critical sowing periods (temporal availability).
Access	People have adequate income or other resources to purchase or barter for appropriate seeds.
Suitability	Seed is of acceptable quality and of desired varieties (seed health, physiological quality, and variety integrity).

Analyses that were undertaken using the seed security framework have revealed that, after a disaster, seed is often available but farmers do not have the resources to buy it, i.e. there is a lack of access to seed. Disasters can be acute or chronic with either a rapid or slow onset. After acute, one-off disasters, seed provision can help vulnerable households resume agriculture production for the following season and rebuild their livelihoods. However, in areas with chronic, slow-onset disasters such as drought in some parts of Africa, the repeated provision of seed will not solve seed or food insecurity. In these chronic seed insecurity situations the establishment of functioning national seed systems as core elements of broader risk management strategies has proved successful. An increasingly used methodology to assess the seed security situation correctly is the Seed System Security Assessment.⁵ These approaches have resulted in the development of new responses to seed insecurity.

³ FAO, 1998

⁴ Remington, 1998; Remington *et al.*, 2002.

⁵ When Disaster Strikes: A Guide to Assessing Seed System Security, Louise Sperling, 2008.

There are several approaches towards obtaining seed for emergency operations: local procurement, market-based approaches to supplying seed locally, and international tenders. For traditional varieties or local landraces of field crops, local procurement or market-based approaches provide the preferred option to ensure that the right crops and varieties are purchased and provided to farmers. International procurement is often used for vegetable seed or when seed is not locally available. Local procurement and market-based approaches are increasingly being used for emergency operations, and new methods such as seed vouchers are being developed. In the rehabilitation phase, seed multiplication is undertaken at the community level to build more sustainable seed security. Procurement within a country works with the national seed systems, whereas international procurement can undermine national seed systems. The following table describes the type of interventions that are adapted to different contexts.

Typology of seed response to emergency

	Description/rationale	Contexts
Direct aid		
1. Direct seed distribution Emergency seed provision "Seeds and tools"	Procurement of quality seed from outside the region for delivery to farmers; the most widely used approach to seed relief.	Short-term response to address problems of seed availability, especially in situations of total crop failure and/or long-term displacement of farmers and/or for crops and varieties that have been introduced and are usually supplied by the formal sector.
2. Local procurement and distribution of seed	Procurement of quality seed from within the region for delivery to farmers. A variant of No.1.	Short-term response to address problems of seed access or highly localized problems of seed availability.
3. Food aid "Seed aid protection ration"	Food aid is often supplied in emergency situations together with seed aid, so that the farming family does not need to consume the seed provided. Where local seed systems are functioning, but the previous harvest was poor, food aid can similarly protect farmers' own seed stocks.	Short-term response accompanying direct seed distribution to address problems of seed availability.
Market-based approaches		
4. Credit or loans to local grain traders and markets	Small-scale grain traders provide a crucial source of seed for farmers, especially in emergencies. Credit or other support to such traders could enable them to source more widely for better varieties and better quality seed, hold larger stocks and improve seed storage.	Short-, medium- or longer-term response to address problems of seed availability, especially in situations of local seed shortages and where seed sourcing through local markets is a widespread practice in normal years.
5. Vouchers/cash to farmers	Vouchers or cash can provide poorer farmers with the means to access seed where it is available in local markets. Vouchers or cash enables farmers to access varieties of their choice.	Short-term response to address problems of seed access, especially in situations of local seed shortages and where local markets or farmer-farmer barter are normally used.
6. Seed fairs	Seed fairs provide an ad hoc marketplace to facilitate access to seeds and varieties from other farmers, traders and the formal sector. They are usually used in conjunction with vouchers to provide poorer farmers with purchasing power.	Short- or medium-term response to address problems of seed access, especially for subsistence crops and where local markets are normally used.

Source: Based on *Towards effective and sustainable seed relief activities*, FAO, 2004.

9.1 LOCAL PROCUREMENT



Seed distribution in Angola

Local procurement has the flexibility to allow purchases at the local markets from farmers and small suppliers who may not be able to respond to a tender. The national seed system (Annex 4) is important to consider when purchasing seed at the country level. In some countries, there is a seed industry with adapted local crop

varieties, and it is just a matter of competitive purchasing of quality seed of the appropriate crop varieties. In other countries, the local seed industry may be very weak or non-existent, and the crop varieties needed are not available from commercial seed companies. Unfortunately, it is often the case that seed must be purchased in a challenging environment where there is no commercial source of the required crop seeds. Local procurement is often necessary when dealing with field crops where the issue of varietal suitability becomes extremely important. In other words, in many areas with emergencies, farmers usually plant local landraces that they prefer and that are well adapted to the local conditions. These traditional varieties or landraces are often referred to as “populations of plants” because of their heterogeneous characteristics. Improved varieties, on the other hand, are much more homogenous, i.e. the plants in the field are nearly identical or uniform. Landraces are often difficult to purchase outside the country or even outside a particular agro-ecology of the country. In the context of varieties of field crops, international tendering may not yield a good response, given that the local varieties are often not known outside the borders of the country. Where local seed companies are the source of the seeds, official labelling and quality assurance procedures exist that ensure as smooth an operation as the international procurement requires. In this case, only a confirmation check by the local seed testing laboratory is required.

At the national level, however, many varieties are localized or are landraces that are not in the portfolios of research institutions or seed companies. It then becomes necessary to procure these from a large number of small suppliers in several locations to make up the bulk or to use other seed relief strategies, such as seed vouchers and fairs, seed vouchers or community-level procurement. The most troublesome aspects of such procurement operations are how to ascertain the identity of the variety or cultivar and then how to ensure that it has an acceptable varietal purity. While for the regular quality parameters, such as analytical purity, germination and moisture content, reliance could be placed on the services of local seed laboratories, the confirmation of variety and assessment of its purity is not a simple process. Local seed procurement of landraces not available from national seed companies should involve national research officers, extension staff, lead farmers or some kind of village committee of farmers to advise on local landraces and source of seed. Supporting local seed production with farmer groups or seed companies under supervision of the national seed service is another strategy for ensuring seed quality of local landraces to use in seed relief activities.

In local procurement, landraces are often preferred; however, there is no clear distinction between seed and food grain in some markets. Consequently, this sometimes leads to food grain being used for seed security activities.

However, there is an element of risk when you consider the difference between seed and food grain. Food grain can be damaged and broken seed, not uniform in size, low in germination, and a mixture of varieties, and yet be acceptable for sale or consumption, but which would not be good for planting. Seed for planting must be able to germinate and produce



Farmers generally prefer local landraces of sorghum in Ethiopia

a good crop. Some seed suppliers clean, sort or process food grain and sell it as seed to relief organizations. The supplier may not be aware of other

seed quality problems that cannot be solved by that practice, such as mixing of crop varieties. Some physical aspects of seed quality can be discerned by observation, but genetic and physiological aspects must be determined by complex tests that cannot be performed quickly. Therefore, there is a strong case for local procurement, particularly of field crops where local landraces are popular.

Guiding principles for the local purchase of seed

- Work with officials from ministries of agriculture, local farmers and leaders to determine the crops and varieties most appropriate for the situation. This should include developing a varietal description (based on the one below) of the specific crop varieties to ensure that the supplier will provide the crop variety specified in the tender. This varietal description can help to avoid any confusion that can arise when only a crop variety name is provided and can result in the wrong crop variety being provided by the supplier.
 - Crop common name (e.g. Maize)
 - Crop species (e.g. *Zea mays*)
 - Variety name
 - Variety type (hybrid, self pollinated, open pollinated, etc.)
 - Geographical areas of varietal adaptation (e.g. temperate, tropical, higher elevation, etc.)
 - Plant height
 - Growth habit (e.g. erect, viny, semi-erect, bush)
 - Growth duration, days to crop maturity (from seeding)
 - Grain or fruit colour
 - Other distinguishing characteristics (if any).
- Identify the agro-ecological zones and the local landraces that will be suitable for procuring appropriate seed for those areas in which you want to distribute seed.
- If possible, purchase seed from surplus-producing areas, so that its purchase will not put too much pressure on seed and food security.
- In some regions, there are farmers and farmer groups that are known as traditional seed producers. Discuss with local experts, NGOs and other trusted local informants to try to determine if there are such groups in your area of operation.

- Identify farmers producing seed early in the agriculture season so that their fields can be monitored to ensure that there is a reasonable level of varietal purity. Since landraces are often not very uniform, high levels of varietal purity can be difficult to achieve.

- Opt for a minimal level of isolation of seed fields in order to prevent the physical mixing of seed from other fields.



- Provide incentives to farmers to produce good seed by offering a price above the market price.

- Clean the seed. Winnowing will help re-

A clear example of impurity in a sorghum seed field. The number of these impurities, or “off-types”, must be limited.

- remove immature seed, chaff, weed seed and inert material from the seed. A good option would be cleaning the seed with an air screen cleaner to further improve its quality, if possible.

- Be sensitive to the time of purchase of seed. If it can be made shortly after harvest, it will provide money to the farmers and not put undue strain on their seed and food security.

- Seed should be sampled so that a representative sample is obtained and tested to determine physical purity, germination and moisture content. This should be carried out before the seed is purchased.

- Ensure that seed is sufficiently dry before purchasing. Do not be in too much of a hurry to buy seed at harvest time when you could risk purchasing seed that is not completely dry. High moisture seed can rapidly deteriorate and become infested with insect pests or with fungus. Seed must be dry to be safely stored.

- Label seed with name, main varietal characteristics and seed quality parameters.

- Follow principles of safe storage to prevent deterioration or insect attack during the storage period.

- Carefully determine quantities of seed per family to meet the needs of the rural family and, if possible, add a little extra if replanting is required.

9.2 TECHNICAL ASPECTS OF MARKET-BASED APPROACHES TO EMERGENCY SEED PROVISION

The use of market-based approaches for emergency seed distribution has been well documented⁶. There is great interest in this approach because it offers farmers a choice in the seed and other inputs they receive and because it creates links between the beneficiaries and the local seed systems, both



A seed fair in Swaziland

formal and informal. Seed relief should work with the national seed system and not damage it through excessive importation of seed. FAO has worked extensively with Input Trade Fairs (ITFs) in southern Africa, particularly in Mozambique, Swaziland, and to a lesser extent in Lesotho. The NGO, Catholic Relief Services, has pioneered the

Seed Vouchers and Fairs (SV&F) approach in East Africa and other parts of the continent. The NGOs World Vision and CARE have worked with vouchers without connecting the vouchers with seed fairs. In addition, seed production at the community level is sometimes promoted as a way to improve seed security. In a chronic drought situation, other strategies are required. What are the key technical aspects of these strategies?

- The involvement of the ministry of agriculture, and in particular, the national seed service, which can assist in field inspection, inspection of seed at ITFs, and provide seed testing.
- Quality standards established for the intervention based on QDS or better, and ensure that the seed suppliers are aware of them.
- Appropriate systems put in place to ensure the quality of the seed provided to the farmers. This could involve testing of seed samples

⁶ CIAT, 2004; CRS, 2002; FAO; 2004.

from a potential supplier before the fair, visual inspection and taking samples during the fair, testing of the samples after the fair, and using the results as a basis for future invitation of the suppliers to the fairs.

- Sufficient supply of quality seed by a range of seed producers, both commercial and farmer producers.
- The multiplication of the traditional varieties of farmer seed producer/seller under a quality assurance scheme that provides them with a certificate so that they can sell seed at the ITFs.

9.3 INTERNATIONAL PROCUREMENT

When varieties to be procured are available on the international market, international procurement might be preferred in order to purchase seed at a better price. In that case, detailed specifications for seed and packaging materials as well as shipment and delivery instructions must be fulfilled by bidders. The successful bidder is the one who satisfies the technical specifications of the tender with the most competitive price and proposes an acceptable delivery time. After the selection of the bidder, the seed will be sampled by a superintendence company and tested at an ISTA-accredited laboratory before shipping to its destination. The seed inspector will also check other requirements such as packaging, weights, markings and labelling.

In international and local procurement, a key issue is to obtain the appropriate crop species and variety for beneficiary farmers. For this reason, it is requested that the emergency staff select crop varieties that are officially approved by the government of the host country. Failure to do so can lead to problems later when the seed is delivered to the farmers.

Seed tenders need to include a varietal description (refer to section 9.1) of the specific crop varieties in order to ensure that the supplier will provide the crop variety specified in the tender. As in local procurement, this varietal description can help to avoid any confusion that can arise when only a crop variety name is provided, which can result in the wrong crop variety being provided by the supplier.

Of particular concern at the technical level is the preparation of the technical specifications (both the varietal description and quality attributes), the evaluation of the bidder's response to these technical specifications, and the evaluation of seed laboratory tests to ensure that the seed meets the required quality standards. Seed specifications are expected to meet the minimum national seed standards of the recipient country and should cover the desired crop species and variety, germination, varietal purity, analytical purity, inert matter and moisture, and also include a declaration that the seeds are free of genetically modified organisms (GMOs). There should

also be a requirement to meet the national plant quarantine legislation. FAO generally establishes technical specifications largely in line with QDS standards as a minimum, but it is obligatory to respect the national standards if they are higher than QDS. A standard format summarizing the technical information that needs to be integrated in technical specifications for seed is included in Annex 6.

Some countries request that only certified seed be distributed. This requirement provides a guarantee on the quality of the seed purchased. However, the system of seed certification varies greatly depending on the country. It is nonetheless advisable to carry out an independent evaluation of seed quality before seed distribution and payment to suppliers.

9.4 ISTA ORANGE CERTIFICATE

The Orange Certificate, or the Orange ISTA International Seed Lot Certificate, is issued based on seed tests that state the specific seed quality test results of a representative sample of a seed lot, for germination, analytical purity, inert matter, other crop seeds and moisture. The Orange Certificate is only issued by ISTA-accredited laboratories. Because most countries have accepted the reliability and accuracy of this certificate, it has become an important aid in enhancing international trade and movement of seed. The certificate covers sampling and testing carried out on a seed lot under the authority of the same member laboratory in one country. Some countries require an Orange Certificate to authorize seed importation. In this case, care must be taken to ensure that the certificates provided by the suppliers refer to the seed lots that are actually being purchased.

10. Seed import regulations

Import regulations are established as an attempt to safeguard a country against the introduction of pests, diseases, and weeds that may be contained in seed imports. There is a long history of the devastating effects of the introduction of exotic pests and diseases, from the cassava mealy bug in West Africa to the grain borer in the United Republic of Tanzania. Seed is one of the means by which exotic pests can be introduced into a new environment, where there are no natural predators. Virtually all countries of the world have scientifically-based import and export regulations for seed and other planting materials, developed under the International Plant Protection Convention (IPPC). One should be aware of the import requirements of the country for which seed is being imported. Such information can be obtained from the National Focal Point of IPPC at the Ministry of Agriculture in the country or on the IPPC website (www.ippc.int). Common examples of these requirements are as follows:

- a) **Phytosanitary Certificate:** This certificate is almost always required for imported seed to ensure that it does not contain a pest or disease that could be harmful to the country. Prior to exporting seeds, they should first be inspected by quarantine officials so that a phytosanitary certificate may be issued. The certificate indicates that all requirements of the importing country have been met; if the conditions of the importing country cannot be met, it should not be issued. A phytosanitary certificate will not normally be issued for seed purchased within a country.
- b) **Import permit:** Certain crops require an import permit. If the phytosanitary conditions cannot be met, the importer may have to obtain an import permit that waives these unmet requirements through additional declarations, such as the inspection of the seed crop in the field, treatment of the seed with fungicide, or other related information.
- c) **Post-entry quarantine:** The seed can be held in quarantine at the point of arrival in the country if deemed necessary by the plant quarantine officials. The quarantine period varies; the time lost in quarantine can be a problem.
- d) **Prohibited crops:** This classification refers to crops that are normally imported only in limited quantities for breeding purposes. A special import permit is issued for the entry of these crops.

For vegetatively-propagated crops such as cassava, banana or sweet potatoes, tissue-cultured materials such as *in vitro* plantlets are the preferred means for international transfer, because pests and diseases are eliminated in the tissue culture process. Potential problems of spreading pests and diseases are therefore avoided.

11. Vegetative planting material

Most of this publication focuses on true seeds. But concerns about quality and types are equally relevant to vegetative planting materials. There is an increasing interest and need to provide vegetatively-propagated planting material to farmers in seed relief operations. These materials comprise plant parts that have the ability to grow into mature plants under the right conditions. Examples of such plant parts are seedlings, rhizomes, corms, sets, cuttings, suckers and tubers, among others, by which plants asexually reproduce. By nature, vegetative planting materials are relatively large and heavy, delicate and perishable, and difficult to store for long periods. With the exception of *in vitro* plantlets that are cultured through biotechnology, they do not lend themselves to the normal procedures for quality checks that are possible in the laboratory for true seeds. As a result, inspection or certification in the field is an important means of checking on quality. Furthermore, owing to their disease-carrying capacity, perishability, as well as local adaptability considerations, they are less likely to be procured (the exception being *in vitro* plantlets) from external sources when required for emergency supplies. The most important crop exception may be seed potato which, because of production difficulties in tropical areas, is often sourced from temperate sources.

In emergency interventions, the most common vegetative planting materials are plantain/banana suckers, sweet potato cuttings, potato tubers, cassava cuttings and a wide range of fruit tree seedlings. For most locations where these are needed, a knowledge of horticulture is often sufficient to offer guidelines on suitable varieties or cul-



An example of symptoms of disease in a cassava field. If material from this field is used for emergency relief, the recipient farmers' fields will be infested as well.

tivars, important insects and diseases, as well as treatment and cultivation guidelines. Although on the whole, seed quality standards have not been adequately developed for locations where the crops are important, the basic recommendations indicated below are suggested as a guide to emergency procurement and distribution.

A primary concern when using vegetative planting material in emergency operations is the transmission of pests and diseases which, if present on or in the living tissue of the vegetative planting material can spread pests and diseases when transported to different areas with the potential of infecting not only the crop but other species. For this reason, particular care should be taken in the production of vegetative planting material, which needs to be inspected by qualified staff and any infected material removed.

- Ensure that materials are free from serious diseases and pests, according to current national recommendations.
- Carry out periodic inspection of the materials to ensure that they are free from diseases and pests during the growing period.
- Ascertain that materials have been freshly harvested and are in good form to sprout and develop (presence of live sprouts, shoots and buds, etc.).
- Check a representative sample of the materials for signs of damage, diseases and pests.
- Obtain expert knowledge on the type (variety, cultivar) in the field before harvesting it.
- Obtain the expert opinion of local horticulturists and establish simple tolerance margins to guide the procurement. Establish tolerance margins or standards, *inter alia*, for percentages of sprouting, alien cultivar, diseased materials (for the major diseases).

Technical specifications for the main vegetatively-propagated crops to be used in emergency procurement have been recently summarized in the “Specifications for emergency procurement of quality planting material - Guidance notes” (FAO, 2010).

Synchronizing activities is extremely important in the procurement/distribution of vegetative planting material for reasons of storage and volume limitations. Procurement and distribution should be so planned that they are aligned with the farmer’s own production preparedness. The materials should be moved from the production sites to the farmer’s field in such a way as to avoid undue transit requiring prolonged storage. In addition, they should arrive at the farmer’s field precisely at the time that the farmer is ready to plant them, so that he or she is not burdened with the problem of prolonged storage and its attendant spoilages.

It is important to note that vegetative planting materials are reproduced true to type and that indigenous knowledge on production is often sound. Therefore, where serious diseases are not a major problem, there is an opportunity to expand the benefits of emergency seed distribution by organizing recipient farmers to pass on - after the harvest - equivalent quantities of materials to benefit other farmers in successive seasons.

Annex 1

GERMINATION TESTING

Germination testing is normally part of the seed testing carried out by seed laboratories. However, emergency staff should be aware of germination testing methodologies when dealing with seed companies or national seed systems, and under certain circumstances be able to perform germination tests when the occasion arises. In the field, there are a number of situations, as indicated below, that would require a relief organization to perform germination tests, particularly if a reliable seed testing laboratory is not accessible:

- if experiencing seed quality problems or complaints from farmers;
- if the seed appears to contain significant quantities of broken seed, inert material, other crop seed, non-uniform seed or discoloured seed;
- if seed has been in transit or stored for several months or with crops that are prone to rapid deterioration such as legumes or oil crops, re-testing seed germination before distribution is particularly important.

General requirements for germination

Germination is the emergence and development from the seed embryo of the essential structures (shoot and roots) that, for a particular seed, are indicative of the ability to produce a normal plant under favourable conditions. There are four general requirements for germination of most seed kinds: suitable substrate, moisture, a favourable temperature and sufficient oxygen. Light is a special treatment needed during germination for overcoming dormancy in certain kinds of seed.

Suitable substrate

- a) Sand:** Clean moist sand (preferably sterilized) in a tray or another suitable container (with drain holes in the bottom) is excellent for germination testing of larger seeds. The top of a BIC pen is perfect for making 1-2 cm holes for the placement of seed in a 10 x 10 pattern. This also provides for easier observation and evaluation. The rule of thumb for planting depth is that it should be twice the length of the seed. Gently cover the seed after placing one seed per hole. The only caution is that other seeds in the sand may confuse counting at germination, but having the seed in a pattern will alleviate this potential problem. An advantage of using sand is that seedlings must push through it and this resistance is a kind of vigour evaluation. Furthermore, the equipment is available even at the village level.

- b) **Cotton cloth:** Commonly called the Rag Doll Method, the test calls for a moist cloth layer underneath the pattern of seed, a moist cloth layer over the seed, and rolling the cloth and seed together. It is better to place the rolled cloth on an incline to aid the evaluation of the seedling. By orienting the rolled cloth, the seedlings are easier to separate and count because the shoots will grow upwards and the roots downwards.
- c) **Paper towels:** Similar to the rag doll method, only two layers of paper towels are placed under the seed with one layer on top, also called the Between Paper (BP) method.
- d) **Blotters:** Depending on the kind of blotter, it can be rolled up, as in the Rag Doll Method, or with small seeds, it can be used in the bottom of Petri dishes, or in similar plastic containers; this is also called the Top-of-Paper (TP) method.

Moisture:

A sufficient supply of moisture is necessary for seed germination. Moisture is normally supplied through the substrate. Excessive moisture can interfere with proper aeration and germination. On the other hand, the substrate should not be allowed to dry out during the germination process. It is important to maintain a moist seed environment, but not excessively wet. Sand should be covered; paper towels, cotton rags and blotters should be kept in loose, sealed plastic bags or boxes. All germination tests should be checked daily to monitor moisture levels and remove mouldy seed.

Sufficient oxygen

Excessive moisture can block the gas exchange of the germination seed. Checking the seed daily and opening the containers will ensure that the seed, even in plastic bags, has sufficient oxygen.

Favourable temperature

Most kinds of seed have an optimum germination temperature alternating between 20°C and 30°C (refer to ISTA rules). This is similar to the alternating night and day temperatures present in many locations. Therefore, ambient temperatures in most locations are suitable for germination. Containers with germinating seed should not be exposed to direct sunlight because of the occurrence of heating. Moreover, it is advisable to conduct germination tests inside rooms or in a shaded area (Annex 2)

Number of seeds:

In germination test procedures, call for testing of at least 400 seeds in replications of 100 seeds in order to have accurate and representative results.

Germination test results

Germination test results fall into at least four major categories, as described below. For our purposes, these are normal seeds/seedlings that will develop into healthy plants and all other seeds/seedlings that include abnormal seedlings, dead seed and hard seed.

Normal seedlings

Normal seedlings possess the essential structures that are indicative of their ability to produce a normal plant under favourable conditions. These seedlings possess a normal and healthy shoot (hypocotyl, cotyledons or epicotyl) and root (primary and secondary).

Abnormal seedlings

Abnormal seedlings will not eventually develop into a healthy plant. Abnormal seedlings are all those that cannot be classified as normal. They often lack a shoot and/or a root.

Dead seed

Dead seeds are those that absorb water, decay and will not produce a seedling during the germination test.

Hard seed

Since these are seeds that do not absorb water, they do not swell and do not start the germination process. This is a problem with a limited number of species that include some legumes.

Seedlings are officially counted after an initial period, i.e. the first count, and then counted again after an additional period of time, i.e. the second or final count. Seedlings are removed once they have fully germinated or if they are mouldy, since fungi can spread to other seeds. The rule of thumb is that the speed at which seedlings emerge is indicative of the seed's vigour. Therefore, the greater the percentage of the normal seedlings on the first count, the higher the general vigour level will be of the seed. This point is very significant for understanding seed quality. Germination test results are reported in terms of:

- total germination percentage of normal seedlings, based on the average of the four replications of 100 seeds;
- total abnormal and dormant percentage, based on the average of the four replications of 100 seeds;
- total hard seed percentage on the average of the four replications of 100 seeds.

N.B. When sand is used as substratum only normal seedlings (and sometimes abnormal seedlings) will emerge from the sand; the dead and hard seed will not emerge. However, when there are poor results on a sand substratum test, it is advisable to retest using a different substratum in order to examine all seeds easily. The use of sterilized sand is recommended for two reasons: the sand can contain seeds of other plants (such as very small weed seed), which can mislead the counting of seedlings; and the sand can contain micro-organisms that can attack the germinating seeds.

Methods of testing for laboratory germination of crop seeds

Crop	Substrate	Temp °C	First count (days)	Second count (days)	Additional
Maize <i>Zea mays</i>	BP, S	20-30 25,20	4	7	KNO ₃
Sorghum <i>Sorghum bicolor</i>	TP, BP	20-30 25	4	10	Pre-chill
Beans <i>Phaseolus spp</i>	BP, S	20-30 25,20	5	9	
Pearl millet <i>Pennisetum glaucum</i>	BP, TP	20-30 20-35	3	7	
Rice <i>Oryza sativa</i>	TP, BP, S	20-30 25	5	14	Pre-heat (50°C); Soak in H ₂ O or HNO ₃ (24 hours)
Wheat <i>Triticum aestivum</i>	TP, BP, S	20	4	8	Pre-heat (30-35°C) Pre-chill: GA
Cowpeas <i>Vigna unguiculata</i>	BP, S	20-30 25	5	8	
Lentils <i>Lens culinaris</i>	BP, S	20	5	10	Pre-chill
Chickpea <i>Cicer arietinum</i>	BP, S	20-30 20	5	8	
Groundnuts <i>Arachis hypogaea</i>	BP, S	20-30 25	5	10	Remove shells, Pre-heat (40 °C)

Source: ISTA Rules for Seed Testing, 2008.

Notes:

1. Substrate: BP=between paper, TP=top of paper, S=in sand,
2. Temperature: single numbers indicate constant temperature. Two numbers indicate alternating temperatures with 16 hours at the first temperature and 8 hours at the second temperature.
3. Light should be provided by a cool white fluorescent source of 750-1 250 lux. The seed should be illuminated for at least 8 hours in every 24-hour period.

Methods of testing for laboratory germination of vegetable seeds

Vegetable	Substrate	Temp °C	First count	Second count	Additional info.
Beets <i>Beta vulgaris</i>	TP,BP,S	20-30 15-25,20	4	14	Pre-wash
Cabbage <i>Brassica oleracea</i>	TP,BP	20-30 20	5	10	Pre-chill:KNO ₃
Carrot <i>Daucus carota</i>	T,B	20-30 20	7	14	
Cucumber <i>Cucumis sativus</i>	TP,BP,S	20-30 25	4	8	Use PP
Eggplant <i>Solanum melongena</i>	TP,BP,S	20-30	7	14	
Lettuce <i>Lactuca sativa</i>	TP,BP	20	4	7	Pre-chill
Melon <i>Cucumis melo</i>	BP,S	20-30 25	4	8	Use PP
Okra <i>Abelmoschus esculentus</i>	T,B	20-30	4	14	
Onion <i>Allium cepa</i>	TP,BP,S	20 15	6	12	
Peppers <i>Capsicum annuum</i>	TP, BP,S	20-30	7	14	KNO ₃
Radish <i>Raphanus sativus</i>	TP,BP,S	20-30 20	4	10	Pre-chill
Spinach <i>Spinacia oleracea</i>	TB,BP	15;10	7	21	Pre-chill
Squash <i>Cucurbita pepo</i>	BP,S	20-30 25	4	8	Use PP
Swiss chard <i>Beta vulgaris</i>	TP,BP,S	20-30 15-25,20	4	14	
Tomato <i>Lycopersicon esculentum</i>	TP,BP,S	20-30	5	14	KNO ₃
Turnip <i>Brassica rapa</i>	TP	20-30 20	5	7	Pre-chill, KNO ₃
Watermelon <i>Citrullus lanatus</i>	BP,S	20-30 25	5	14	Use PP

Source: ISTA Seed Testing Rules

1. Substrate: BP=Between paper, TP=top of paper, S=in sand.
2. Temperature: single numbers indicate constant temperature. Two numbers indicate alternating temperatures with 16 hours at the first temperature and 8 hours at the second temperature.
3. Light should be provided by a cool, white fluorescent source of 750-1 250 lux. The seed should be illuminated for at least 8 hours in every 24-hour period.

Annex 2

VEGETABLE SEED COUNT AND SEEDING RATES

Vegetable	Seed per 10 g range		Seeding rate grams per 100 m ² transplanted	Seed rate grams per 10 m ² direct seeded
Beets	500	650	-	11.0
Cabbage	2 800	3 500	3.0	-
Carrot	8 000	10 000	-	4.5
Cucumber	300	400	-	2.7
Eggplant	2 000	2 500	4.0	1.7
Kale	3 000	4 000	4.0	3.0
Lettuce	6 000	10 000	5.0	1.7
Melon	300	400	-	2.0
Okra	140	180	-	7.5
Onion	2 800	3 500	30.0	6.0
Pepper	1 500	2 000	4.5	2.2
Pumpkin	50	70	-	3.7
Radish	1 000	1 400	-	11.0
Spinach	1 000	1 500	-	13.0
Swiss chard	400	600	-	9.5
Tomato	3 000	4 000	1.75	1.2
Turnip	3 500	4 000	-	2.5
Watermelon	100	140	-	2.5

Source: East Africa Seed Co., 2002.

Annex 3

SEED QUALITY STANDARDS FOR EMERGENCY ACTIVITIES

Based on FAO Quality Declared Seed (QDS)

Cereals	Varietal purity ¹ (min. %)	Analytical purity ² (min. %)	Germination (min. %) ³	Moisture content (max. %) ⁴
Maize	98	98	80	13
Pearl millet	98	98	70	13
Rice	98	98	75	13
Sorghum	98	98	70	13
Wheat	98	98	80	13
Food legumes				
Beans	98	98	70	10
Broad beans	98	98	70	10
Chickpeas	98	98	75	10
Cowpeas	98	98	75	10
Dry peas	98	98	75	10
Groundnuts	98	98	70	10
Lentils	98	98	70	10
Mung beans	98	98	75	10
Soybeans	98	98	70	10
Oil crops				
Sesame	98	98	70	10
Sunflower	98	98	70	10
Industrial crops				
Cotton	98	98	70	10
Castor bean	98	98	70	10

In determining seed quality, the working seed sample is separated into three fractions - pure seed, seed of other crops (includes weed seed) and inert matter. In the QDS specifications, seed of other crops, weed seed and inert matter should be at an acceptable maximum level.

- ¹ **Varietal purity:** the percentage of the pure seed that will produce plants that exhibit the characteristics of that specific crop variety. This can only be determined through DNA fingerprinting and/or field inspection of seed crop plots.
- ² **Analytical purity:** the percentage of the seed that is of the same crop species but not necessarily the same crop variety. The balance can include inert matter, weed seed, damaged seed. While regular seed testing procedures may not in all cases distinguish between different varieties of the same species, the seeds of different crop (species) can be identified in the seed laboratory by close examination of the seed.
- ³ **Germination:** the percentage of the seed with the ability to germinate and that can develop into plants under appropriate field conditions of optimum moisture, aeration and temperature. For international procurements of vegetable seed, the minimum germination should be 80 percent.
- ⁴ **Maximum moisture content:** recommended for safe storage and good germination. Values may vary to crop types (starchy vs. oil/high protein content seeds) and according to local conditions, in particular with environmental relative humidity and temperature. Local standards should be applied.

SEED QUALITY STANDARDS FOR EMERGENCY ACTIVITIES

Based on FAO Quality Declared Seed (QDS)

Vegetables	Varietal purity ¹ (min. %)	Analytical purity ² (min. %)	Germination (min. %) ³		Moisture content (max. %) ⁴
			Local tender	International tender	
Amaranthus	98	95	70	80	8
Beetroot	98	95	70	80	8
Cabbage	98	98	70	80	8
Carrot	98	97	70	80	8
Cauliflower	98	98	70	80	8
Celery	98	97	70	80	8
Chinese cabbage	98	98	70	80	8
Cucumber	98	98	70	80	8
Eggplant	98	98	70	80	8
Leek	98	97	70	80	8
Lettuce	98	97	70	80	8
Melon	98	98	70	80	8
New Zealand spinach	98	97	70	80	8
Okra	98	98	70	80	8
Onion	98	97	70	80	8
Parsley	98	95	70	80	8
Radish	98	98	75	80	8
Spinach	98	97	70	80	8
Squash	98	98	70	80	8
Sweet pepper & chili	98	98	70	80	8
Swiss chard	98	95	70	80	8
Tomato	98	98	75	80	8
Turnip	98	98	70	80	8
Watermelon	98	98	70	80	8

¹ **Varietal purity:** the percentage of the pure seed that will produce plants that exhibit the characteristics of that specific crop variety. This can only be determined through DNA fingerprinting and/or field inspection of seed crop plots.

² **Analytical purity:** the percentage of the seed that is of the same crop species but not necessarily the same crop variety. The balance can include inert matter, weed seed, damaged seed. While regular seed testing procedures may not in all cases distinguish between different varieties of the same species, the seeds of different crop (species) can be identified in the seed laboratory by close examination of the seed.

³ **Germination:** the percentage of the seed with the ability to germinate and that can develop into plants under appropriate field conditions of optimum moisture, aeration and temperature. For international procurements of vegetable seed, the minimum germination should be 80 percent.

⁴ **Maximum moisture content:** recommended for safe storage and good germination. Values may vary according to crop types (starchy vs. oil/high protein content seeds) and according to local conditions, in particular with environmental relative humidity and temperature. Local standards should be applied.

Annex 4

THE NATIONAL SEED SYSTEM

Seed emergency operations must be conducted within the context of the seed systems in the country. The figure below provides a conceptual overview of a national seed system so that the relationship of the various sectors can be better understood. National seed systems vary greatly among countries: some countries have strong national seed systems with well developed agricultural research, national seed service and private sector seed companies; others have weak national seed systems with the community-based seed system providing most of the seed used by farmers. Nevertheless, emergency staff should collaborate closely with national partners in the national seed system, particularly the national seed service.

The national seed system can be conceptualized as three intersecting circles representing its main components: agricultural research as the source of improved varieties, the commercially-oriented seed supply sector involved in the production of certified seed, and the community-based seed supply sector where farmers produce, save and exchange seed.



Commercially-oriented seed supply (formal seed system): In the figure above, the intersection of the upper left circle and the lower centre circle (“**Variety Improvement**”) represents the plant breeders in the private sector and/or in public research institutes or international institutions developing new crop varieties with desired characteristics, such as high yield, tolerance to pests and diseases, appropriate organoleptic (taste and cooking) characteristics

for personal consumption and sale in the market. **Variety improvement** is essentially the output of agricultural research to the national seed system. After rigorous testing, the best new varieties are released through a national variety release system ready to be used by farmers. The early generations of these released varieties are then multiplied by government seed services or the private sector with appropriate quality control by the **national seed service and private seed sector** (in the upper left circle).

Later generations of the released varieties are multiplied by the private sector within a quality assurance programme to become certified seed that meets specific quality standards. The seed is sold as certified seed to farmers through agriculture input supply stores, regional markets, weekly markets, seed traders, government programmes and NGOs in **local markets** (intersection of the commercial sector and farmer sector, top centre of the figure). Local market refers to all types of market linkages between producer and consumer/user. Therefore, it is in the local market where commercial seed and the farmer-produced seed are both present. In some countries, commercial seed is only available in input supply stores in the capital and major towns. In more remote regions, the only seed available may be from weekly markets or from small traders. In some markets, there is not a clear distinction between food grain and seed for planting.

Conservation and use of Plant Genetic Resources for Food and Agriculture (PGRFA) (intersection of all three circles in the centre of the figure) refers to the commercial sector, agricultural research and the farmer, and the means by which local PGRFA are conserved in gene banks and by farmers in their fields, and are used for developing new crop varieties. The local PGRFA can be the basis for development of new varieties and continue to play an important role as the local landraces that farmers use. For improved varieties developed by agricultural research, new varieties are tested both in research plots and on farmers' fields.

When farmers are involved in variety development by providing feedback on new varieties to plant breeders, this is referred to as **participatory plant breeding** (intersection of the lower circle and upper right circle).

The roles of the commercially-oriented seed supply and the community-based seed supply can vary by crop, region of the country, importance of the crop for food and for cash, as well as other factors. For example, in many countries in eastern and southern Africa, there is a commercially-oriented seed supply for important cash crops such as maize. However, for other important food crops such as sorghum, millet or beans the commercial seed sector in the same countries may not be well developed. The **commercially-oriented seed supply component** of the national seed system operates with the seed policy and national seed legislation, and phytosanitary regulations of the government.

In developing countries, the formal seed system (commercially-oriented seed supply sector) may not reach the small-scale farmers, and new, improved varieties are often not adapted to their needs owing to low input production practices and diverse agro-ecologies. In addition, these varieties are often more vulnerable to drought or environmental stresses and do not meet organoleptic requirements. Until new improved varieties of certified seeds are demonstrated in small-scale farmers' fields, it cannot be assumed that they are adapted to farmers' needs. However, improved varieties that have undergone testing by small-scale farmers can prove to be a welcome addition to their diverse crops and varieties.

Community-based seed supply sector (informal/farmer seed system):

This refers to the upper right circle in the figure, in which farmers in developing countries use traditional methods to produce and exchange seed through social networks and save their own seeds for the following planting season. For most farmers, this is their primary source of seeds. In the farmer seed system, both production and sourcing of seed often vary for each crop, resulting in a total system that can be very complex. Farmers value their seed, which has been passed down through generations. This system includes the selection of plants at harvest time or during storage. Selected grain to be used as seed is often stored separately from other food-grain and cleaned before planting. Seeds that farmers plant are usually well adapted to their agro-ecological zones and have the desired characteristics for consumption and/or sale as seed or food-grain. However, the increasing incidence of drought means that farmers often seek earlier maturing, drought-resistant varieties.

Farm families plant a diversity of crops and often several different varieties of each crop in a wide range of agro-ecologies. Farmer seed production systems are often specific to each crop. Farmer seed systems also include the introduction of new materials that come from social networks, communities, markets, seed companies, extension workers and NGOs. Therefore, **PGRFA conservation and use** are extremely important for vulnerable farmers as well as the commercial sector. PGRFA include both the local and introduced crop diversity that are so important to a country's agriculture sector.

When an emergency arises, farmer/community-based and commercially-oriented seed systems are impacted, and farmers turn to other sources, such as social networks, NGOs, seed traders and the government to replace their seed stocks. Governments may opt to purchase local modern seed varieties for input distribution to the affected farmers. A large injection of non-domestic emergency seed - if it is not appropriate - into the national seed system can have a negative effect on the vulnerable farmers

who receive the seed. At the same time, imported seed can have a negative impact on the commercially-oriented seed sector or may sometimes help the commercial sector to overcome seed availability problems resulting from an emergency.

What are the appropriate actions to take to re-establish seed security in a way that enhances the farmer seed system and does not cause its further collapse? It is important to perform a seed security assessment in order to have a better understanding of the problem and implement the appropriate seed relief activities. The national seed system (both commercial and informal systems) should be strengthened - not damaged- as a result of an emergency and relief interventions that follow.

Annex 5

GLOSSARY

Abnormal seedlings - Seedlings that in a germination test show damages on critical structures of the embryo, with the likelihood that the capacity for continued development into a normal plant may not materialize. The critical structure(s) may be damaged, deformed, decayed, or reveal other defects

Air screen cleaner - The basic piece of equipment for cleaning seed, using air flow and perforated screens for sieving action in the separation of the seed from inert materials, weed seed and other crop seed (taking into account the differences in the size, shape and weight of seed and that of the contaminants), resulting in cleaner seed of a more uniform size.

Analytical purity - The percentage by weight of the seed that is of the required crop species. The impurities can include inert matter, weed seed, damaged seed and other crop seed.

Certified seed - Seed of a prescribed standard of quality, produced under a controlled multiplication scheme, either from basic seed or from a previous generation of certified seed. It is intended either for the production of a further generation of certified seed or for sowing to produce food, forage, etc.

Clone - A group of individuals (plants) of common ancestry that have been propagated vegetatively, usually by cuttings or by multiplication of bulbs or tubers.

Commercial seed - Seed that is intended for crop production, but that has not been produced under a recognized certification scheme.

Composite sample - A sample made by mixing together the primary samples drawn from containers of the seed lot for testing purposes.

Cultivar - Synonymous with the term “variety”.

Dormancy - The condition in which a seed with a viable embryo fails to germinate in conditions conducive to plant growth.

Embryo - The generative part of the seed that will develop into a plant.

Endosperm - The nutritive tissue within a seed but external to the embryo on which the developing seedling can draw nutrients until it is able to photosynthesize on exposure to light.

F1 - The first generation arising from a cross between two genetically different parents, usually in-bred lines.

Foundation seed - The progeny of breeder seed, used as planting stock for registered and certified seed.

Genetic purity - Trueness to type or variety, usually referring to the specified crop variety as represented by seed.

Germination - Initiation of active growth of all essential embryonic parts required for a successful seedling establishment. In a seed test, it is regarded as the emergence and development from the seed of the essential structures that indicate the ability of the embryo to develop into a normal plant under favourable field conditions.

Germination capacity - The percentage of pure seed that germinates in a standard test to give normal seedlings as defined in the ISTA International Rules of Seed Testing.

Germination rate - The percentage of the pure seed with the ability to germinate and that can develop into normal seedlings under appropriate conditions of optimum moisture, temperature and light.

Hybrid vigour - The increase in vigour of hybrids over their parental inbred lines; also known as “heterosis”.

Inert matter - One of the four components of a purity test; it includes non-seed material, straw, stones and seed material that is classified as inert according to the ISTA International Rules of Seed Testing.

Inbred - Self-fertilized over several generations.

ISTA - The International Seed Testing Association member laboratories establish the international standards and procedures for seed testing.

Isolation - The separation of the field of seed crop from the field of other crops in order to prevent mechanical or genetic contamination of the seed to be harvested. Isolation could be in the form of distance, time and physical barriers.

Normal seedlings - Seedlings that in a germination test show the capacity for continued growth and development into normal plants.

Noxious weeds - A weed species defined by law as being noxious; usually highly objectionable when found in crop seed lots. Technically, it is a weed seed that is difficult to control by any known cultural means.

Off-type - A plant in a seed crop that deviates from the typical description of the cultivar.

Open-pollinated variety - A heterogeneous variety of a cross-pollinated crop that is allowed to inter-pollinate freely during seed production; in contrast to hybrid seed production representing controlled cross-pollination.

Phytosanitary certificate - A certificate issued by a legally constituted authority of the federal or state government stating that a seed lot has been inspected and found to be free of quarantine diseases. These certificates are frequently used in international seed trade agreements to prevent the spreading of seed-borne diseases among countries.

Pollination - The transfer of pollen grains from an anther of a flower to a stigma of the same or another flower followed by fertilization of the ovule.

Primary sample - A small portion of seed taken from one point in a seed lot during the sampling process.

Progeny - Offspring.

Pure seed - The species stated on the label or found to predominate in the test and which includes all botanical varieties and cultivars of that species, including whole seed, immature seed, diseased seed, and seeds larger than one-half of their original size, or as defined by ISTA rules for seed testing.

Registered seed - A class of seed in a certified seed scheme that is produced from foundation seed and planted to produce certified seed.

Relative humidity - The ratio, expressed as a percentage, of the quantity of water vapour actually present in the air, to the greatest amount of vapour that could be present at that temperature.

Respiration - The metabolic process by which a plant oxidizes its food and provides energy in a form that it can immediately use.

Rogue - A contaminant (cultivar, other species or weed) in a seed crop. Roguing is the process of removing rogues from the crop.

Sampling - The method by which a representative sample is taken from a seed lot to be sent to a laboratory for analysis.

Seed - The ripened ovule, consisting of an embryonic plant together with a store of food or other structure including the ovule, used by farmers as planting material.

Seedling - A young plant as it emerges from the seed until it is established physically and physiologically as a completely independent plant.

Seed lot - A quantity of seed of one cultivar, of known origin and history, and controlled under one reference number.

Seed equilibrium moisture content - The percentage of moisture in a seed at a particular temperature and relative humidity.

Stamens - The parts of the flower that contain the anthers (represents the male part).

Seed vigour - The sum of the properties that determine the activity and performance of the seed lots of acceptable germination in a wide range of environmental conditions. A vigorous seed lot is one that is potentially able to perform well even under environmental conditions that are not optimal for the species.

Stigma - The surface to which pollen grains are transferred for fertilization of ovules (represents female part).

Submitted sample - A sample submitted to the testing laboratory. It must be of at least the size specified by ISTA regulations and may comprise either the whole or a sub-sample of the composite sample.

Sub-sample - The portion of a sample obtained by reducing the sample using one of the sampling methods prescribed in ISTA regulations.

Variety - Synonymous with the term “cultivar” as defined in the International Code of Nomenclature for Cultivated Plants, 1980, Art. 10: “The international term cultivar denotes an assemblage of cultivated plants which is clearly distinguishable by a group of characters (morphological, physiological, cytological, chemical or others) and which, when reproduced (sexually or asexually), retains its distinguishing characteristics.”

Varietal purity - The percentage by weight of pure seed that will produce plants that exhibit the characteristics of that specific crop variety.

Weed - An unwanted plant appearing in a cultivated crop.

Working sample - The sample taken in a laboratory from a submitted sample and actually used in a test.

Annex 6

TECHNICAL SPECIFICATIONS FORMAT FOR SEED PROCUREMENT

[Formato de especificaciones técnicas para la compra de semillas]

[Format des spécifications techniques pour l'achat de semences]

1. General information [Información general] [Information générale]

a. Requirements by FAO [Requisitos de FAO] [Requis par la FAO]

Crop common name [Nombre común del cultivo] [Nom commun de la culture]	Crop scientific name [Nombre científico del cultivo] [Nom scientifique de la culture]	Variety name [Variedad] [Nom de la variété]	Total quantity requested (kg) [Cantidad total solicitada (kg)] [Quantité totale requise (kg)]	Delivery date [Fecha de entrega] [Date de livraison]
_____	_____	_____	_____	_____

Varietal characteristics [Características varietales] [Caracteristiques de la variété]

Variety type (OPV, Hybrid, Self-pollinated) [Tipo de variedad (polinización abierta, híbrido, autopolinización)] [Type de variété (pollinisation ouverte, hybride, autogame)]	_____
Days to maturity [Días hasta la madurez] [Nombre de jours jusqu'à maturité]	_____
Grain/fruit colour [Color de las semillas/fruto] [Couleur du grain/fruit]	_____
Plant height [Altura de la planta] [Hauteur de la plante]	_____
Growth habit [Porte de la planta] [Port de la plante]	_____
Specific resistance/tolerance to biotic factors (e.g. fungi; bacteria; viruses) [Resistencia/tolerancia a factores bióticos (e.g. hongos; bacterias; virus)] [Résistance/tolérance aux facteurs biotiques (e.g. maladies fongiques; bactéries; virus)]	_____
Specific resistance/tolerance to abiotic factors (e.g. low/high temperature, frost, water-logging, low/high soil pH; etc.) [Resistencia/tolerancia a factores abióticos (e.g. temperaturas altas/bajas, helada, encharcamiento del suelo, pH del suelo alto/bajo etc.)] [Résistance/tolérance aux facteurs abiotiques (e.g. températures élevées/basses, gel, excès d'eau, pH du sol bas/élevé; etc.)]	_____
List of countries/areas where the variety is successfully cultivated [Listado de países/áreas en los que la variedad se ha cultivado con buenos resultados] [Liste des pays/régions où la variété a été cultivée avec de bons résultats]	_____

b. Offer by the bidder [Oferta del licitador] [*Offre du fournisseur participant*]

Producer Company [Compañía productora] [*Entreprise productrice*]: _____

Country of production [País de producción] [*Pays de production*]: _____

Crop common name [Nombre común del cultivo] [<i>Nom commun de la culture</i>]	Crop scientific name [Nombre científico del cultivo] [<i>Nom scientifique de la culture</i>]	Variety name ⁷ [Variedad ¹] [<i>Nom de la variété¹</i>]	Quantity offered (kg) [Cantidad ofertada (kg)] [<i>Quantité proposée (kg)</i>]	Price (USD) [Precio (USD)] [<i>Prix (USD)</i>]
_____	_____	_____	_____	_____

⁷ If the variety offered is not the one required in the specifications, please provide the key varietal characteristics of the variety offered (see page 4)
[Si la variedad que se ofrece no es la que se solicita en las especificaciones, indicar las características varietales principales de la variedad que se ofrece (ver página 4)]
[*Si la variété proposée par le fournisseur est différente de la variété demandée dans les spécifications techniques, indiquer les principales caractéristiques de la variété qui seraient fournies (voir page 4)*]

2. Technical information [Información técnica] [Informations techniques]

Crop common name: _____

[Nombre común del cultivo]

[Nom commun de la culture]

	Technical specifications required by FAO [Especificaciones técnicas solicitadas por FAO] [Spécifications techniques requises par la FAO]	Actual characteristics of the seed offered (to be filled by the bidder) [Características reales de las semillas que se ofrecen (a completar por el licitador)] [Caractéristiques réelles des semences proposées (à remplir par le fournisseur)]	Comments [Comentarios] [Commentaires]
Varietal purity ⁸ [Pureza varietal] ² [Pureté variétale] ²	_____ % minimum [% mínimo]	_____ %	_____
Analytical purity ⁹ [Pureza analítica] ³ [Pureté spécifique] ³	_____ % minimum [% mínimo]	_____ %	_____
Germination ¹⁰ [Germinación] ⁴ [Germination] ⁴	_____ % minimum [% mínimo]	_____ %	_____
Moisture content [Contenido de humedad] [Taux d'humidité]	_____ % maximum [% máximo]	_____ %	_____
Seed treatment (when needed) [Semilla tratada (si es necesario)] [Semences traitées (si nécessaire)]	Product name [Nombre del producto] [Nom du produit] _____	Product name [Nombre del producto] [Nom du produit] _____	_____
Exotic diseases and pests [Enfermedades y plagas] [Maladies et parasites]	Absent [Libre] [Absents]	_____	_____

⁸ Varietal purity: the percentage of the pure seed that will produce plants that exhibit the characteristics of that specific crop variety.

[Pureza varietal: El porcentaje de la fracción de semilla pura que produce plantas con las características específicas de la variedad.]

[Pureté variétale: pourcentage de semences pures qui produiront des plantes ayant les caractéristiques spécifiques de la variété]

⁹ Analytical purity: the percentage of the seed that is of the same crop species but not necessarily the same crop variety.

The impurities can include inert matter, weed seed, damaged seed, other crop seed.

[Pureza analítica: el porcentaje de la semilla que pertenece al mismo cultivo aunque no necesariamente a la misma variedad. Las impurezas pueden incluir: materia inerte, semillas de malezas, semilla dañada, y semillas de otros cultivos.]

[Pureté spécifique: pourcentage de semences de la culture considérée mais pas nécessairement de la même variété. Les impuretés peuvent être: des matières inertes, des semences de mauvaises herbes, des semences endommagées ou des semences d'autres cultures.]

¹⁰ Germination: the percentage of the pure seed with the ability to germinate and that can develop into normal seedlings under appropriate conditions of optimum moisture, temperature and light.

[Germinación: el porcentaje de semillas dentro de la fracción semilla pura que produce plantulas normales bajo condiciones optimas de humedad, temperatura y luz.]

[Germination: pourcentage des semences ayant la capacité de germer et de donner des plantules normales dans des conditions optimales d'humidité, de température et de lumière.]

3. Packaging [Embalaje] [Emballage]

	Technical specifications required by FAO [Especificaciones técnicas solicitadas por FAO] [Spécifications techniques requises par la FAO]	Actual characteristics of the seed offered (to be filled by the bidder) [Características reales de las semillas que se ofrecen (a completar por el licitador)] [Caractéristiques réelles des semences proposées (à remplir par le fournisseur)]
Weight of containers: [Peso de cada contenedor] [Poids des emballages]	_____ kg	_____
Containers are marked with project number, variety name, germination rate, moisture content, weight, seed treatment used, date of harvest [Contenedores marcados con el simbolo del proyecto, variedad, indice de germinación, contenido de humedad, peso, tratamiento de semillas utilizado, fecha de cosecha] [Emballages identifiés avec le code du projet, la variété, le taux de germination, le taux d'humidité, le poids, les traitements effectués sur les semences, date de récolte]	_____	_____
Packaging type [Tipo de envasado] [Type d'emballage]	_____	_____
Tags and logos [Etiquetado y logos] [Etiquettes et logos]	_____	_____

4. Other information [Otras informaciones] [Autres informations] (to be completed by the bidder [a completar por el licitador] [à remplir par le fournisseur])

Is the seed lot accompanied with a phytosanitary certificate ¹¹ ? [¿Está el lote acompañado por un certificado fitosanitario ⁵ ?] [Le lot de semences est-il accompagné d'un certificat phytosanitaire ⁵ ?]	_____
Does the offered seed lot contain GMO? [¿Tiene el lote Organismos Genéticamente Modificados (OGM)?] [Le lot de semences contient-il des Organismes Génétiquement Modifiés (OGM)?]	_____
If yes, please provide a declaration on extent of GMO in the seed consignment [En caso de respuesta afirmativa, por favor proporcionar una declaración sobre la cantidad de OGM presente en cada lote] [Dans le cas où le lot de semences contient des OGM, merci de fournir une déclaration précisant la quantité d'OGM présente dans chaque lot]	_____

If the variety offered is not the one required in the specifications, please provide the key varietal characteristics of the seeds offered. These should include:

[Si la variedad que se ofrece no es la que se solicita en las especificaciones técnicas, se ruega indicar las características varietales principales de las semillas que se ofrecen. Estas deben indicar:]
[Si la variété proposée par le fournisseur est différente de la variété demandée dans les spécifications techniques, merci d'indiquer les principales caractéristiques de la variété qui serait fournie. Devront être inclus:]

Crop common name [Nombre común del Cultivo] [Nom commun de la culture]	_____
Variety name [Variedad] [Nom de la Variété]	_____
Variety type (OPV, Hybrid, Self-pollinated) [Tipo de variedad (polinización abierta, híbrido, autopolinización)] [Type de variété (pollinisation ouverte, hybride, autogame)]	_____
Days to maturity [Días hasta la madurez] [Nombre de jours jusqu'à maturité]	_____
Grain/fruit colour [Color de las semillas/fruto] [Couleur du grain/fruit]	_____
Plant height [Altura de la planta] [Hauteur de la plante]	_____
Growth habit [Porte de la planta] [Port de la plante]	_____
Specify resistance/tolerance to biotic factors (e.g. fungi; bacteria; viruses) [Especificar la resistencia/tolerancia a factores bióticos (e.g. hongos; bacterias; virus)] [Spécifier la résistance/tolérance aux facteurs biotiques (e.g. maladies fongiques; bactéries; virus)]	_____
Specify resistance/tolerance to abiotic factors (e.g. low/high temperature, frost, water-logging, low/high soil pH; etc.) [Especificar la resistencia/tolerancia a factores abióticos (e.g. temperaturas altas/bajas, helada, encharcamiento del suelo, pH del suelo alto/bajo; etc.)] [Spécifier la résistance/tolérance aux facteurs abiotiques (e.g. températures élevées/basses, gel, engorgement en eau du sol, pH du sol bas/élevé etc.)]	_____
List of countries/areas where the variety is successfully cultivated [Listado de países/áreas en los que la variedad se ha cultivado con buenos resultados] [Liste des pays/régions où la variété a été cultivée avec de bons résultats]	_____

¹¹ In case of international procurement
[En caso de compra internacional]
[En cas d'achat international]

References

Catholic Relief Services. 2002. *Seed vouchers and fairs: a manual for seed-based agricultural recovery in Africa*. Baltimore, Maryland, USA.

International Center for Tropical Agriculture (CIAT). 2004. *Addressing seed security in disaster response: linking relief with development*. Cali, Colombia.

East African Seed Company. 2002. *Growers' guide. Planting chart for vegetables*. Nairobi, Kenya.

FAO. 2006. *Quality declared seed: technical guidelines for standards and procedures*. FAO Plant Production and Protection Paper 185, Rome, Italy.

FAO. 2004. *Towards effective and sustainable seed relief activities*. FAO Plant Production and Protection Paper 181. Rome, Italy.

International Seed Testing Association (ISTA). 2004. *International rules for seed testing*. Bassersdorf, Switzerland.

Office of U.S. Foreign Disaster Assistance (OFDA). 1996. *Report on seed for disaster mitigation and recovery in the Greater Horn of Africa*. USAID with Chemonics International and USDA FMA.

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Seeds in Emergencies: a technical handbook

The seed security of small-scale rural households is often put at risk by natural and human-caused disasters. As a consequence, seeds are frequently provided to vulnerable households as part of the emergency response. However, seeds are unlike other inputs such as fertilizer or tools because they are fragile living organisms with specific quality attributes. In addition, crop varieties must be adapted to the targeted agro-ecological zone and meet the preferences of the local households. Farmers' seed systems are complex and seed exchange is highly regulated at the national and international levels.

This publication provides emergency practitioners with the basic technical information about seeds, necessary for planning and implementing seed relief interventions. It defines the main seed quality attributes and describes the standard testing and sampling methodologies. Maintaining seed quality in emergency situations is a key issue and therefore the main factors of seed quality deterioration are presented, including handling and storage. Basic principles of seed production are described to assist emergency practitioners in seed sector rehabilitation. International regulations affecting seed production and trade are also discussed. Finally, key concepts of seed security assessment are provided, as well as the different types of seed relief interventions. This technical publication is part of FAO's effort to assist its member countries, FAO emergency staff and humanitarian partners to improve emergency preparedness and response to seed insecurity.

