

Appropriate Seed Varieties for Small-scale Farmers



Humanitarian Aid
and Civil Protection



Appropriate Seed Varieties for Small-scale Farmers: Key Practices for DRR Implementers

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- Information and Knowledge Management (COOPI)
- Mobile Health Technology (COOPI)
- Safe Hospitals (COOPI)
- Disaster Risk Reduction for Food and Nutrition Security (FAO)
- Appropriate Seed Varieties for Small-scale Farmers (FAO)
- Appropriate Seed and Grain Storage Systems for Small-scale Farmers (FAO)
- Farmer Field Schools (FAO)
- Irrigation Techniques for Small-scale Farmers (FAO)
- Management of Crop Diversity (FAO)
- Community-based Early Warning Systems (OCHA and FAO)
- Disaster Risk Reduction Architecture (UN-Habitat)

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Humanitarian Aid
and Civil Protection

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Foreword

by ECHO

The southern Africa and Indian Ocean region is extremely vulnerable to cyclones, floods, droughts and tropical storms. These recurrent climate-related shocks negatively affect the highly sensitive livelihoods and economies in the region, and erode communities' ability to fully recover, leading to increased fragility and vulnerability to subsequent disasters. The nature and pattern of weather-related disasters is shifting, becoming unpredictable, and increasing in frequency, intensity and magnitude as a result of climate change. Vulnerability in the region is further compounded by prevailing negative socio-economic factors, such as high HIV rates, extreme poverty, growing insecurity and demographic growth and trends (including intra-regional migration and increasing urbanization).

The European Commission's Office for Humanitarian Affairs (ECHO) has actively engaged in the region through the Disaster Preparedness ECHO (DIPECHO) programme since 2009, supporting multi-sectorial disaster risk reduction interventions in food security and agriculture, infrastructure and adapted architecture, information and knowledge management, water, sanitation and hygiene, and health. This programme operates with two objectives, notably:

- Emergency preparedness by building local capacities for sustainable weather-hazard preparedness and management, including seasonal preparedness plans, training, emergency stocks and rescue equipment, as well as Early Warning Systems.

- Empowering communities through multi-sectorial and multi-level approaches with DRR mainstreamed as a central component and improved food and nutrition security as an outcome.

This is done in alignment with national and regional strategies and frameworks.

For DIPECHO, one of the main measures of success is replicability. To this end, technical support through guidelines established for DRR implementers is a welcome output of the DIPECHO interventions in the region. ECHO has supported regional partners, namely COOPI, FAO, UN-Habitat and UN-OCHA, to enhance the resilience of vulnerable populations in southern Africa by providing the funding to field-test and establish good practices, and to develop a toolkit for their replication in southern Africa. It is the aim of the European Commission Office for Humanitarian Affairs and its partners to fulfil the two objectives sustainably and efficiently through the practices contained in this toolkit to ensure the increased resilience of the most vulnerable populations in the region.

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Foreword

by FAO

The southern Africa region is vulnerable to a diverse array of hazards, largely linked to environmental causes (such as drought, cyclones and floods); human, animal and plant diseases and pests; economic shocks; and in some areas socio-political unrest and insecurity, among others. The region's risk profile is evolving, with new factors becoming gradually more prominent, including a trend towards increased urbanization, migration and mobility, among others. Natural hazards will be progressively more influenced by trends in climate change. Disasters in the region are often composite and recurrent, and have a dramatic impact on livelihoods and on southern African countries' economy and environment, often undermining growth and hard-won development gains.

Increasing the resilience of livelihoods to threats and crises constitutes one of the Strategic Objectives of FAO's Strategic Framework (Strategic Objective 5, or SO5). FAO specifically aims at building resilience as it relates to agriculture and food and nutrition security, which are among the sectors most severely affected by natural hazards. The impact of shocks and disasters can be mitigated and recovery can be greatly facilitated if appropriate agricultural practices are put in place; improving the capacity of communities, local authorities and other stakeholders is therefore central to resilience building.

Together with partners, FAO is undertaking intensive work in southern Africa to consolidate the resilience of hazard-prone communities; this is leading to an improved knowledge base and to documentation of good practices. This toolkit purports to disseminate improved methods and technologies on key aspects of agriculture, such as appropriate seed varieties, irrigation, storage systems, land and water use and Farmer Field Schools, in the hope that they may serve different stakeholders to improve their resilience-building efforts. A multi-sectoral approach and solid partnerships are seen as key to the success of resilience-building work. For this reason, this toolkit also includes non-agricultural aspects of good resilience practices, contributed by FAO partners: the UN-OCHA, UN-HABITAT and COOPI, which certainly strengthen this collection.

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Acronyms and Abbreviations

COOPI	Cooperazione Internazionale
DRR/M	disaster risk reduction/management
FAO	Food and Agriculture Organization of the United Nations
ISTA	International Seed Testing Association
NGO	non-governmental organization
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OPV	open-pollinated variety
QDPM	quality declared planting material
QDS	quality declared seed
SADC	Southern Africa Development Community
UN-Habitat	United Nations Human Settlements Programme

1. Introduction

Objective

The objective of this technical brief is to provide concise and clear descriptions of the key aspects for the promotion of quality seed of appropriate varieties for use by small-scale farmers, in the context of the disaster risk reduction/management (DRR/M) activities in the southern African region.

Natural disasters such as droughts, floods and hurricanes, and man-made disasters, such as wars and civil conflicts, have a 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. To attain food security, farmers need to have access to seed of appropriate varieties in adequate quantities, of acceptable quality, in time for planting. Seed security is therefore crucial for the resilience of farmers in areas affected by disasters and therefore for their food security. Addressing the seed security of households affected by disasters or in areas prone to hazards requires technical knowledge and expertise to ensure the effectiveness of the DRR/M interventions.

While global seed markets can offer a great diversity of crops and crop varieties with a wide range of characteristics in terms of adaptation to environmental conditions, production systems and properties of the end-products, small-scale farmers in many developing countries have very limited access to those varieties and to the knowledge associated with them. The situation is more critical in hazard-prone areas, where poor and vulnerable farmers may not even have access to the traditional sources of seed of their preferred varieties.



To increase the resilience of farming systems to recurrent disasters, farmers need access to seed of crop varieties that can perform well under these challenging conditions, in addition to being adapted to their local environmental conditions and meeting their consumption and market requirements. The choice of an appropriate crop and an appropriate variety to be adopted by hazard-prone farmers in the context of DRR/M interventions is complex and must take into consideration a number of factors. Tolerance to drought, short cycles to reduce the risk of coinciding with hazards, and resistance to the pests and diseases prevalent in the target area are desirable characteristics for hazard-prone farming systems. These should be combined with other



benefits like sufficient yield, the possibility of re-using the seed during more than one season, and adaptation to the local natural and cultural environments during the decision-making process.

The Food and Agriculture Organization of the United Nations (FAO) has a long history of work in supporting southern African small-scale farmers to enhance their food and seed security. Through its DRR/M activities, FAO seeks to protect livelihoods from shocks, to make food production systems more resilient and capable of absorbing the impact of and recovering from disruptive events. To this end, this technical brief will assist DRR/M practitioners in identifying problems related to seeds and varieties, and in taking appropriate actions. Availability of practical information can increase the effectiveness of interventions.

Intended application

This brief is appropriate for field staff of FAO and its implementing partners involved in DRR/M programmes. It provides basic technical knowledge required for operations related to seed, including introduction of new crop varieties, seed acquisition and seed production/multiplication by farmers.

Government officers, extension workers and non-governmental organizations (NGOs) will also find this document useful as a reference for training activities, and when planning and implementing initiatives related to appropriate seed aimed at improving the livelihoods of rural communities.

2. Key Concepts and Principles Related to Crop Varieties and Quality Seed

Crop varieties

A species is a basic unit of biological classification. Maize, beans, cassava and banana are examples of plant species used in agriculture for their edible parts. However, it is evident that within a species there can be a wide range of different types of plants. Within each cultivated plant species, it is possible to find differences in the shape, colour and size of the various parts of the plant, and also in other less perceptible characteristics like

yield or resistance to diseases. A plant variety represents a more precisely defined group of plants, selected from within a species, with a common set of characteristics.

Traditional and improved varieties

Crop varieties can be classified into two broad categories by the way in which their characteristic properties were developed: *traditional varieties* and *improved varieties*. Traditional varieties (also known

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as landraces, local varieties or farmers' varieties) were selected by farmers over many generations for their special characteristics, and normally are well adapted to the natural and cultural environment in which they are grown. Although sometimes they may not be uniform, farmers recognize their specific morphological characteristics (shapes, sizes and colours of the plant parts), production properties and specific uses.

Improved or modern varieties are those obtained after a systematic and scientific process of selection and breeding. Plant breeders change the traits of plants in order to produce desired characteristics and increase their value. Increased crop yield is the primary aim of most plant breeding programmes, but other advantages of the new varieties that have been developed include adaptation to new agricultural areas, greater resistance to disease and insects, an altered agricultural calendar to enable production outside of traditional production periods, higher efficiency in the use of the available water and better nutritional content, among others.

In the context of DRR/M interventions, some of these characteristics may be of great interest. For example, the use of varieties with short growth periods (short-cycle varieties) can help to avoid the coincidence of the plant development period with peak natural hazard seasons. The manipulation of plants to create new varieties can be done in several ways, including the selection of a single best plant progeny (pure line) among a heterogeneous population, the systematic crossing of related (classical breeding) or dissimilar

(hybridization) plant varieties, and the manipulation of the plant genes to insert desired traits into plants (molecular breeding), among others.

The process of developing new varieties which have the desired characteristics and which meet the requirements of distinctness, uniformity and stability takes a great deal of time and resources; at the same time, the resultant new varieties generally can be easily and quickly reproduced by consecutive seed-saving and replanting. For this reason, plant breeding companies usually protect their new varieties with intellectual property rights.

Despite the clear advantages of improved varieties, especially with regard to yield, their use in subsistence agricultural systems must be appraised carefully. Because they are generally commercial products, they usually depend on market availability, are protected by intellectual property rights and often require more costly inputs like fertilizers and pesticides. In addition, some of them (like hybrids) require the purchase of seed every season. These important issues should be taken into account when planning the introduction of improved varieties in DRR/M interventions.

Research has shown that small-scale farmers usually prefer traditional varieties because they are better adapted to withstand environmental stresses such as lack of water or nutrients. They are also cheap and easily accessible by saving part of the crop production on the farm (in situ) to be used as seed in the following season, or by local purchase or exchange.

Plant pollination: self-pollinated and cross-pollinated crops

A significant technical aspect related to the management of seed and varieties is the way a particular crop species is pollinated and whether it is self-pollinated or cross-pollinated. Basically, in self-pollinated crops, within a single flower the male (stamen) and female (stigma) parts are very close together, and through physiological processes such as the timing of the release of the pollen and the receptiveness of the stigma, the plant will self-pollinate. 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 carrots.

Cross-pollinated crops are characterized by plants in which self-pollination is prevented by either mechanical, biological or other obstructions. For example, 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 such cases, wind and insects are often important for pollination.

There can be considerable cross-pollination among different fields of the same crop, up to a distance of half a kilometre or

more as a result of wind, and even greater distances as a result of insect-based pollination. Consequently, these crops have the potential to be heterogeneous. Through large isolation distances from other crops of the same species and selection of plants for seed at harvest, farmers can maintain a degree of control of varietal purity 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. Millet and sorghum, for example, which are mainly self-pollinated, have an out-crossing rate of between 5 and 20 percent.

Hybrids and open-pollinated varieties

All traditional varieties of cross-pollinated crops are open-pollinated, meaning that their pollination is not necessarily controlled. Some improved varieties of cross-pollinated crops are also open-pollinated, but others are hybrids, produced by the controlled cross-pollination of unlike parents of the same plant species. Because the parents are genetically different, hybrids have 'hybrid vigour' (the opposite of consanguinity) resulting in increased growth, size, yield or other characteristics over those of the parents. However, when a hybrid is pollinated with another hybrid, the offspring will not have hybrid vigour and, in fact, it may grow poorly and have inferior performance. Herein lies the problem with the use of hybrids in small-scale agriculture: traditional farming practices often rely on farmers producing and saving seed for planting in the following

season which will be ineffective when the seed has been produced from a hybrid variety.

Unlike hybrids, in open-pollinated varieties (OPVs) the pollination is carried out by natural mechanisms (insects, birds, wind or others) and they produce seed that will grow into plants more or less like their parent plants, remaining fairly consistent for several generations, although less uniform than hybrids. 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 relatively stable. Seed production of OPVs mainly requires that isolation distances are respected, but it does not require the use of sophisticated pollination control methodologies. For this reason, it is advisable to use OPV in seed saving or seed production operations in the context of subsistence agriculture.

When working with OPVs and when varietal purity is to be maintained, special precautions may have to be taken to avoid gradual changes in the variety characteristics (including yield and quality) after several multiplication cycles ('degeneration of the seed').

This can be reduced if after harvest farmers systematically select large grain from healthy plants of the required variety to be used as seed for the following season. There is a general recommendation to obtain new seed every three or four seasons to avoid seed degeneration, but this period can be extended depending on the crop, the variety, the health status and the field practices implemented.

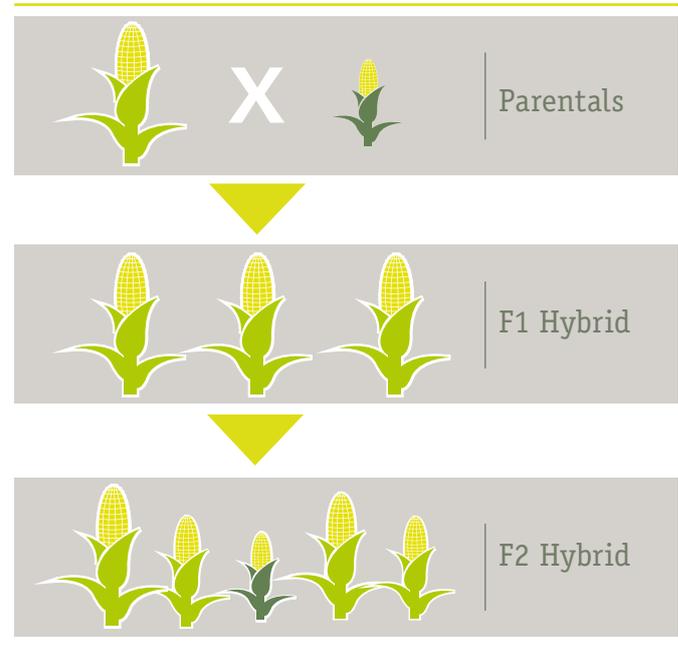


Figure 1: F1 hybrids are uniform and have hybrid vigour. However, the subsequent generation (F2) is heterogeneous and does not have hybrid vigour

The distinction between hybrids and OPVs is very important in cross-pollinated crop species: maize, rice, sorghum, millet and many vegetables like tomato, squash, melon, onion and cucumber. It is usually possible to obtain both types of varieties of these crops from commercial seed companies. Although plant breeders have also developed hybrids for self-pollinated crops like rice and wheat, their adoption rates in most parts of the world (including southern Africa) are low.

Adaptation of varieties to local conditions

Plants will grow well in the proper environmental conditions of climate and soil. Varieties of the same crop can have different morphological or genetic characteristics that make them specifically adapted to an agro-ecological zone. Yield and quality of the harvested product depend, to a large extent, on the adaptation of the variety to the area where it is cultivated.

The most relevant characteristics of adaptation to the local conditions are:

- **Length of the growth cycle.** This is critical for rain-fed crops in particular to enable them to mature while there is sufficient water in the soil for grain filling. When conditions are good, a late maturing (long-cycle) variety typically gives a higher yield than other varieties. However, especially in drought conditions, farmers may be interested in early-maturing (short-cycle)

varieties that can be planted late in the season or harvested before the end of the season, to reduce the risk of damage by drought.

- **Climate requirements.** Temperature and rain regimes, the amount of rainfall, risk of drought, solar radiation and day length should be taken into consideration.
- **Soil requirements.** Tolerance to acidity or salinity and the availability of water and nutrients must be considered.
- **Resistance to damage by diseases, insects and other pests.** The ability of plants to live with these organisms without significant loss of yield and quality must be considered. Obviously, tolerance to major diseases and pests is extremely important and a major objective of plant breeders. Tolerance and resistance can break down with time owing to mutations in parasites or hosts. New sources of resistance and tolerance are always being sought by plant breeders.

As a general rule, traditional varieties are well adapted to the local conditions of the area where they have been grown and developed. However, they may not be necessarily adapted to other areas. Indigenous farmers recognize the differences among the traditional varieties they grow, and know which of them are suitable for planting at particular locations and times. With regard to improved varieties, some were developed to do well in particular zones, but in many cases breeding programmes aim at producing varieties

with adaptation characteristics to a wide range of agro-ecological conditions. It is difficult to anticipate how a variety (either traditional or improved) will respond to a specific agro-ecological zone until it is actually grown there. Therefore, before recommending the use of a variety in a zone, it is important to obtain precise and comprehensive information on its adaptation characteristics, and if possible, the successful results of variety trials of several years either in the target zone or in another with very similar environmental characteristics.

Seed and planting material

In a broad sense, seed is a material that is used for planting or regeneration. Botanically, a true seed is a fertilized matured ovule, consisting of an embryonic plant, a store of food (cotyledons and endosperm) and a protective seed coat. However, from the seed technology point of view, seed also refers to propagating materials of healthy seedlings, tubers, bulbs, rhizomes, roots, cuttings, setts, slips, and all types of grafts and vegetatively propagating materials used for production purposes.

Seed is the most vital and crucial input for crop production; one of the best ways to increase productivity without adding appreciably to the extent of land under cultivation is by planting quality seed.

Seeds have specific requirements for initiation of germination: a suitable substrate, a favourable moisture level, a favourable



temperature in the environment around the seed, and a favourable oxygen supply. Some seeds may also require specific light conditions; others need to have their dormancy¹ broken when the seed is exposed to specific conditions like the passage of time, the removal

¹ Dormancy is the state of non-germination in viable seed. During this period, germination is blocked by conditions within the seed.

or breaking of the seed covering, low temperatures for long periods, or the effects of light or hormones supplied to the seed. Seed dormancy is uncommon in cultivated plants. By controlling these conditions it is possible to control seed germination, which should be prevented during seed storage and other handling operations, and occur when seed is sowed in the field.

The difference between grain and seed

Sometimes, especially with regard to cereals and legumes, there is confusion between the terms 'seeds' and 'grains' but each has a separate meaning and characteristic features. Besides their botanical differences, the main difference between grains and seeds is in their uses: while grain is normally used for food and feed, seed is used for the reproduction of the plant. Seeds must keep their viability until the time of sowing, with the purpose of ensuring the development of a new plant and the production of a good harvest. To ensure that the seed maintains its viability at least between the harvest and the next sowing, it should undergo a careful process of drying, cleaning and sometimes chemical treatment to prevent damage from pests and diseases. When storing seeds, it is necessary to maintain low levels of temperature and air humidity to avoid unintended germination (for more information on storage of seed and grain, see the *Appropriate Seed and Grain Storage Systems for Small-scale Farmers* brief in the present series).

If a seed loses or reduces its capacity to generate a new plant, it can be used as grain, but only if it has not been treated with chemicals that could have an impact on human or animal health.

Seed quality

Quality seed is critical to agricultural production: poor seed limits the potential yield and reduces the productivity of the farmer's labour and other production inputs.

There are four basic parameters for seed quality: physical quality, physiological quality, genetic quality and health status.

a) Physical quality

Good physical quality of the seed in a seed lot is characterized by the following:

- **Minimal damage to 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.
- **Minimal diseased seed.** Discolouration and staining 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 rates and vigour than small and immature seed. After harvest, 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. Closely examining handfuls of seed is the first step to a better understanding of the quality of seed; it gives the opportunity to decide on seed-cleaning needs.

b) Physiological qualities: viability

A basic requirement of seed is that it must germinate at the right time.

The *germination rate* (percentage of seed germinating within a seed lot) 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.

In hot and humid conditions, the seed may quickly lose its ability to germinate; the rate of deterioration varies among crop types.



Starchy seeds, for instance those of cereals like maize, generally have a slower rate of deterioration compared with those of legumes like groundnut and soybean, which are oily and have high protein content. The moisture content of the seed and the temperature of the building where it is stored are the most critical factors affecting the rate of deterioration. The lower the temperature and relative humidity, the longer the seeds can be safely stored.

The importance of physiological quality cannot be undervalued. Seed can only fulfil its biological role if it is viable. Therefore, physiologically uniform seed of an adapted variety will be useless if it is low in germination rate and vigour, or if it fails to germinate when planted.

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c) Genetic quality

Varietal uniformity is very important, both when crops are produced for the market and for agronomic reasons. A mixture of varieties may mature at different times, which can lead to problems in harvesting and post-harvest handling, and results in lower yields. Seed of different varieties of the same crop is often difficult or even impossible to distinguish once harvested and therefore varietal purity has to be determined in specialized seed laboratories.

However, traditional varieties or landraces, particularly of cross-pollinated varieties used by subsistence farmers, are often not very uniform. This heterogeneity can be an advantage in some circumstances such as those of low rainfall, low fertility and pest and disease pressure.

d) 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 to assess the quality of seed sanitation.

Ensuring seed health is important because diseases initially present in the seed may give rise to progressive disease development in the field and reduce the commercial value of the crop. In addition, imported seed lots may introduce diseases or pests into regions where they were not present before. For this reason,

countries have legislation on plant and seed health, specifying cases where seed must be held in quarantine at the point of arrival into the country.

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 it can be fumigated. Special precautions need to be taken when treated seed is distributed to farmers, who should receive instructions on the appropriate way to handle it and be warned about the danger of its use for human consumption.

Vegetative planting material

Vegetatively propagated planting materials comprise plant parts that can grow into mature plants under the right conditions. Vegetative propagation is clonal, i.e. progeny are genetic copies of the parent plant. Although all members of the same clone have the same genetic makeup and can be exactly alike, environmental factors can modify the expression of the genetic character so that the appearance and behaviour of individual plants can be clearly different.

Seedlings, rhizomes, corms, sets, cuttings, suckers and tubers, among others, are examples of plant parts that enable reproduction that is not sexual reproduction and does not require true seeds. Potato is traditionally grown from tubers, cassava from stem cuttings,

sweet potato either from vine cuttings or storage roots, and banana and plantain from corms (stems similar to bulbs) or suckers (shoots that arise from an underground root or stem), to mention only the most important in southern Africa.

By nature, vegetative planting materials are relatively large and heavy, delicate and perishable, and difficult to store for long periods. Farmers usually produce their own materials or obtain them in their communities. The most important exception may be potato tubers used for planting which, because of production difficulties in tropical areas, are often sourced from temperate climates. A primary concern when working with vegetative planting material is the transmission of pests and diseases which, if present on or in the living tissue of the planting material, can spread pests and diseases when transported to different areas; this could result in infection not only of the crop, but also of other species. For this reason, particular care should be taken in the production and handling of vegetative planting material, which needs to be inspected by qualified staff and any infected material removed. Basic recommendations include:

- Periodic inspection of the materials to ensure that they are free from diseases and pests during the growing period.
- Ascertaining that materials have been freshly harvested and are in good form to sprout and develop (for instance, that live sprouts, shoots and buds, etc. are present).
- Ensuring that materials are free from serious diseases and pests, in accordance with national recommendations.

3. Key Steps Required in the Field

Choosing the appropriate crop

Development institutions in southern Africa and other regions often encounter difficulties in promoting the adoption of new crops and improved varieties by small-scale farmers. One of the main reasons for this has been the lack of understanding of what farmers want or how they assess crops and varieties. There are several considerations that influence farmers' choice of crops:

- Household food security is vital to farmers as it ensures their livelihood. The combination of crops chosen must ensure food security throughout the seasons.
- Income generation, because agricultural products are farmers' main source of income.
- Land quality and quantity, because when land is scarce farmers may choose to plant the crop that is most important for their food security (often maize), or high value crops (like vegetables).

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Fertile land may be used to maximize yields and profits, while poorer land is usually allocated to less demanding crops.

- The need for inputs because farmers must allocate limited resources among agricultural inputs (fertilizers, seed, tools) and other expenses.
- Consumer preferences and intended use will affect how farmers select their crops; they will select those that meet their households' (for self-consumption) and community's (for sales) needs and preferences in terms of taste, colour, size, or cooking characteristics. In addition, if the crop is intended for other uses, such as animal feed, there are specific varieties that are best suited for this purpose which differ from those for human consumption.



- Farming experience and education have also proved to be important because trained farmers are usually more receptive to changes in production systems.

The choice of a wrong or unsuitable crop or variety can impact highly on household food security, on profits and also on the future adoption of new technologies.

Choosing an appropriate variety for introduction

It is important for farmers to select the varieties most suited to their conditions from the different varieties of crops available. Recommendations should take into account the wide range of factors that influence the decisions made by farmers, in order to contribute to the successful adoption of new crop varieties by smallholder farmers.

Most of the above-mentioned factors on the choice of crops are also relevant when choosing a variety. Basically, what farmers expect in a new variety is:

- A variety that can improve their livelihoods, providing both food and income.
- A variety that performs well each season under the local soil and climate conditions, providing yield stability. Drought, pests or any other environmental conditions should not endanger food/income security.
- A variety that is not too expensive to grow. This cost perception will depend on farmer preferences. For instance, if farmers can

recycle seed by using open-pollinated maize varieties instead of hybrid maize varieties, they could save money for acquiring other inputs, particularly fertilizers.

- Seed that is easily accessible on the market, affordable to purchase and from a trusted source.

Choosing the wrong or inappropriate variety can result in loss of yield, which may lead to food and nutrition insecurity and impoverishment. For example, some imported varieties may never mature or may yield much less than expected because they are not adapted to environmental conditions in a particular area.

As mentioned above, traditional varieties have important advantages that should be considered when selecting a crop variety. One of the most important is their adaptation to the local conditions, and especially their resistance to the pests and diseases present in the area. In contrast, improved varieties (both hybrid and OPV) usually produce considerably higher yields and products that can be marketed better, which are major factors in food security and income generation.

As a general rule, the use of hybrids in small-scale agriculture is not recommended because seed has to be bought each season and requires costly inputs like fertilizers and pesticides. This can be a serious handicap after a shock, and undermine farmers' resilience.

A major factor in the selection of the right variety, especially in the context of DRR/M activities, is the length of the growing season. This determines the ideal maturity group of the variety to be introduced.

An early-maturing (short-cycle) variety can either be planted early and harvested before the end of the season, or be planted late and harvested by season-end. It is also recommended in areas where the rainy season is short, rain patterns are irregular or in situations of chronic drought. A usual constraint in working with short-cycle varieties is that they tend to produce lower yields than other varieties. However, yields of short-cycle improved varieties can, in most cases, be higher than those of traditional varieties.

Other important elements related to the general characteristics of the target area are:

- Yield potential of the area. This is related to rainfall and temperature patterns, soil characteristics, elevation and other



environmental factors. Some varieties are more suitable for low- and some for high-yield-potential areas.

- Prevalent diseases and pests in the area. Look for varieties with resistance or tolerance to prevalent diseases and pests.
- Crop choice of neighbouring farms. Learn from successes and failures of neighbouring farmers.

Availability of such information helps to determine what characteristics a variety needs to perform well. These may include, for example, the degree of disease resistance or whether drought- or soil-acidity tolerance is required.

It is also crucial to keep in mind the criteria of consumers, considering:

- Targeted use of the final product. Different varieties are often preferred when the grain is for processing and storage at home, compared with when it is intended for sale, processing, feed/silage or for other special purposes.
- Prevailing market conditions.
- Quality attributes in terms of the end-product. Local consumers may have preferences on taste, colour, size or cooking characteristics of the product.

In general, farmers see new varieties as risky because their survival depends on the success of their crops. This is why they tend to be reluctant to change and it takes time to introduce new varieties. New varieties should always be tested in small areas for several

seasons before being widely introduced in an area. When possible, demonstration days in fields planted with new varieties are useful to allow farmers to compare and appreciate their advantages.

Another important element when working with improved varieties is their release and protection status. In most countries, new varieties must be registered in an official list or catalogue before they can be marketed. The registration process requires that a number of tests be conducted before registration.

Lists of protected varieties include those for which the individuals or organization obtaining them have been granted protection under intellectual property law. In such cases, the variety generally cannot be multiplied without the authorization of the intellectual property rights holder.

Before recommending the use of a variety for introduction, it is essential to find out its release and protection status in the country: it is important that the variety to be bought (in case of improved varieties) is listed in the national register of released varieties, and that seed of a protected variety is not multiplied for the purposes of selling the seed.

Seed acquisition

The promotion of new varieties for adoption by farmers in the context of DRR/M interventions normally requires obtaining seed from sources which are not locally available in the area of intervention. An important element for DRR/M practitioners when buying seed

is to understand the characteristics of the different seed sources, as well as the standards and requirements that should be followed to maximize the efficiency of interventions. This section provides guidelines for the acquisition of seed in DRR/M interventions.

There are several approaches towards obtaining seed including: local procurement within or outside the region; importing seed from other countries; or contracting seed production in advance. When some quantity of seed is available, seed multiplication at the community level can help to build more sustainable seed security.

Purchasing seed from available stocks in the country is usually the most cost-effective option, and it also allows direct access to

information about the type and quality of the seed. In some situations seed of the appropriate variety for introduction may not be available in the country in the quantity and quality required, and the only option is importing it from abroad.

a) Seed acquisition in local and national markets

For traditional varieties or local landraces of field crops, local procurement is the preferred option to ensure that the right crops and varieties are purchased and provided to farmers. Usually, the quality of the seed sourced in local markets is acceptable to farmers, as it is generally grown nearby and so meets their needs. Also, in normal situations seed is more available and accessible to farmers through this channel in terms of proximity, appropriate time and price.

The commercially oriented seed supply (or 'formal' seed system) provides farmers with improved varieties in the form of high quality seed. Plant breeders in the private sector, public research institutes or international institutions develop new crop varieties with desired characteristics such as high yield, tolerance to pests and diseases, appropriate taste and cooking characteristics for consumption and sale in the market. 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 seed companies with appropriate quality control. Seed is then marketed through officially recognized outlets. The formal seed system is especially important when seed is used



to grow crops for commercial purposes or when a new crop variety is to be introduced into the farmer-seed system.

In some countries, there is a seed industry with adapted local crop varieties, but 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 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.

The following principles can guide the local procurement 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 simple varietal description² of the specific crop varieties.
- In the tender process, the varietal description will help to ensure that the supplier will provide the crop variety specified. This varietal description can help to avoid any confusion that may arise when only a crop variety name is provided and can result in the wrong crop variety being provided by the supplier.
- Identify the agro-ecological zones and the local varieties that will be suitable for procuring appropriate seed for those areas in which seed will be distributed.
- 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.

² Including crop name, crop species (scientific name), variety name, variety type (self-pollinated, hybrid, OPV), geographical areas of varietal adaptation, plant height, growth habit, growth duration (days from seeding to maturity), grain or fruit colour, and any other distinguishing characteristics.

- Verify that a minimum quality of the seed is ensured. When possible, buy seed certified by a national seed laboratory and obtain the results of the quality analysis. If this is not possible, seed should be tested to determine physical purity, germination and moisture content. This should be carried out before the seed is purchased. In cases where it is possible to order from a seed company, the production of the seed and varietal

purity of the seed can be verified by inspection of the seed production fields.

- 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 fungus. Seed must be dry to be safely stored.³
- Label seed with name, main varietal characteristics and seed quality parameters.

b) International seed 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. A key issue is to select the appropriate crop species and variety for beneficiary farmers. For this reason, it is requested that the field 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.

Detailed specifications for seed and packaging materials, as well as shipment and delivery instructions, must be fulfilled by bidders.

³ FAO Quality Declared Seed Standards (see Annex B) establish the maximum levels of moisture content in the seed for purchase. For cereals the standard is 13 percent, and for food legumes and oil crops (like groundnut or soybean) it is 10 percent.



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 a laboratory that has been accredited by the International Seed Testing Association (ISTA) before shipping to its destination. The seed inspector will also check other requirements such as packaging, weights, markings and labelling. Seed tenders need to include a varietal description 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 helps to avoid any confusion that arises 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.

There should also be a requirement to meet the national plant health legislation. This legislation is different in each country, but

requirements can include a phytosanitary certificate, an import permit and post-entry quarantine at the point of arrival in the country if deemed necessary by the plant quarantine officials. FAO generally establishes minimum technical specifications that are mostly in line with quality declared seed (QDS) standards, 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 A.

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.

International procurement is often used for vegetable seed.

Seed storage

The viability of seed declines during storage, but this can be minimized with appropriate temperature and moisture control. High temperatures and moisture favour the proliferation of insects, bacteria and fungi.

Seed purchased for distribution 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 regular storage inspections.

Usually, it is not practical to control the temperature and relative humidity of the space where seed is stored. Therefore, a building should be selected where the temperatures are moderately low most of the time, and where the seed is not exposed to humid conditions. For example, maize seed with a moisture content below 13 percent and a high (over 80 percent) germination rate is still viable after over a year of storage at 25° C and 50 percent relative humidity.

Bags containing seed should be kept off the floor and walls because moisture can seep into the bags and affect seed moisture content, seed deterioration rates and seed germination. This can be done by laying them on pallets or on tree branches placed in a lattice formation on the floor. Vegetable seeds stored for prolonged periods of time should be kept in hermetically sealed containers or sealed plastic containers to avoid rapid deterioration.

Some seed-borne diseases can be controlled or suppressed by 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.

Storage structures and practices should also protect the seed against damage by rats and other rodents. Storage structures for food grains are often designed with this in mind.

Principles of seed production by farmers

In general, the conditions and cultivation practices that lead to good crop yields also lead to good seed and a good seed yield. Each crop, with the related ecological conditions, is different and requires particular management decisions for seed production and handling. In this section the main principles for seed production are described, but crop-specific technical guidelines should be followed



for each case (for more information on storage, see the *Appropriate Seed and Grain Storage Systems for Small-Scale Farmers* brief in the present series.)

Many crops (cereals, legumes, oil crops and others) are grown for their seed; therefore, the farming practices for seed production generally follow the standard production methods for the crop. In contrast, other crops (most vegetables, fruits, forages and many vegetatively propagated crops like cassava or sweet potato) are



not cultivated for their propagation material, and the cultivation practices are specific to each case.

Although the processes and good practices of seed production and crop production are similar in terms of planning and maintenance (plot selection, crop rotation, seed rate, timing of planting, sowing, tillage and fertilization) particular attention and more strenuous measure to ensure the integrity of the seed producing plants and fields must be taken, and these practices must be followed most vigorously.

This is particularly important in the final stages of plant development when seeds are usually formed.

With regard to the above, some practices are particularly critical:

- Isolation distances between fields planted with the same crop should be maintained to prevent pollination from neighbouring fields, which could negatively impact in varietal purity.⁴
- Choose high-quality 'mother seed'. The higher the quality (varietal purity, health status) of the seed planted, the more likely that the seeds produced will also be of high quality.
- Pest, disease and weed control is especially important because it can have an impact on plant development and on seed (or planting material) development. Seed damaged by pests or diseases may have low viability rates. The control of seed-borne diseases is particularly important to avoid propagation of diseases.

⁴ FAO Quality Declared Seed Standards include minimum isolation distances between the seed production field and other fields of the same crop. A summary of these standards is included in Annex B.



- Harvest and threshing operations have to be done with great care to avoid damaging the seed.

Seed production fields should be examined regularly to confirm that plants develop properly, conform to the characteristics of the variety and are free from weeds, pests and diseases.

To ensure seed quality, seed should be dried quickly after harvest. This will make the seed viable for a longer period and will also prevent micro-organism and insect growth. However, high temperatures can cause damage. Sun-drying can normally be completed in a few days. When seed is dried on the floor, regular turning will improve the balanced drying of the seed lot and avoid the growth of mould at the bottom of the layer. When harvesting is done during a humid period, small-scale dryers fuelled by wood can be an option, but only if the financial means is available and if farmers have experience in their use, as it is critical to avoid over-heating the seed.

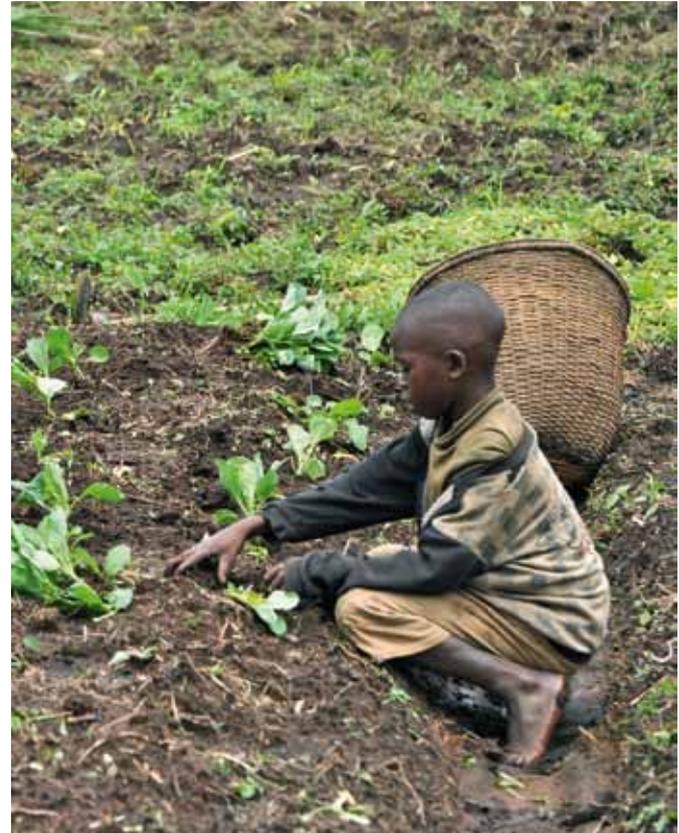
After drying, seed has to be cleaned to remove non-crop seed materials from the harvested material such as straw, stones and weed seed. Cleaning also allows the selection of seeds according to physical characteristics such as size, shape, density and colour. As a general rule, grain of good size should be selected for seed. For example, in the case of maize, it is important to look for large cobs and select the grains from the middle part of the cob, rejecting the smallest and those that have symptoms of disease.

For most crops, cleaning of seed is done in the same way as cleaning of food grain, and local methods for cleaning food grains are well suited to seed cleaning. They include: winnowing to remove light particles like straw and dust; sieving to select the seed by shape; and size and hand-picking to remove diseased and discoloured seeds. All seed infested by insects must be destroyed. This will effectively remove sources of future infestation or contamination.

When possible, seed should be treated, either with organic substances like ash and natural compounds or by chemicals, after harvest to reduce losses during storage. When seed treatment with chemicals is possible, the choice of the chemical and the application method should be made with extreme care because they can be very toxic.

It is important to avoid storing seed in direct sunlight or in hot places. Traditional structures like those with mud walls or underground spaces often provide sufficient insulation to keep temperatures moderately low. Vegetable seed is usually small and not much of it is required at community level. Therefore, airtight containers like glass jars or bottles are adequate for its storage, if they can be well sealed; they also solve possible insect problems.

Storage containers like bags or barrels, as well as the storage structure, should be cleaned and disinfected prior to storage of newly harvested seed. Stored seed should be inspected regularly to detect and correct problems.



Ensuring seed quality: certified seed and quality declared seed

Various quality assurance procedures have been established for determining quality standards for seed, based on the seed quality attributes mentioned previously. As part of their seed legislation, countries establish regulations that include a quality assurance scheme for certified seed. Seed certification adds value and marketability to the seed by documenting its quality.

A buyer of certified seed can be confident that the seed in the bag is of the variety indicated on the container, and has a high germination rate and minimal content of other crop and weed seeds.

The process of certification usually requires the formal inspection of the field seed production and seed processing, as well as confirmation from independent laboratories that the seed meets the quality standards established.

Most countries stipulate quality standards for the importation of seed. At an international level, SADC (the Southern Africa Development Community) has established a seed certification and quality assurance system to ensure that seed traded among its 15 member countries is of consistently high and known quality.

Whenever possible, seed purchased in DRR/M interventions for distribution to farmers should be certified. In the international procurement of seed, FAO requests an ISTA Orange certificate verifying that an ISTA-accredited laboratory collected a representative seed sample on which the seed tests were performed. For seed purchased in-country, certified seed complies with the requirements of the national legislation.

FAO has developed guidelines and protocols for the production of quality seed, called the quality declared seed (QDS) system. The system provides an alternative for seed quality assurance, particularly designed for countries with limited resources, which is less demanding than full-seed quality control systems (like seed certification), yet guarantees a satisfactory level of seed quality.

For each crop, QDS provides guidelines for facilities and equipment, land requirements, field standards, field inspections and seed quality standards. For each crop, QDS provides guidelines for facilities and equipment, land requirements, field standards, field inspections and seed quality standards. A summary of the QDS for seed of some crops is included in Annex B. Similarly, the quality declared planting material (QDPM) system of FAO provides standards for the production of quality planting material of a number of vegetatively propagated crops.

4. Technical Considerations and Specifications

Choosing the appropriate crop and variety

- As much information as possible should be collected on:
 - **Local farming systems:** the crops and varieties traditionally grown (cash crops and food security crops), land availability per household, access and use of inputs like fertilizers, among other considerations.
 - **Local environmental conditions:** climate and soil conditions, pests and diseases prevalent in the area, occurrence of natural hazards (droughts, floods).
- Systems by which farmers have access to seed: on-farm saving, exchange with neighbours, commercial seed markets.
- Crops and crop varieties available in the seed market at community and national levels, and their characteristic features.
- Obtain advice from the government (ministries of agriculture, extension services), local experts, lead farmers and farmers' associations on the most appropriate crop varieties for introduction.
- Appropriate crop varieties should meet the requirements of:
 - food and nutrition security and income generation;



- adaptation to local environmental conditions;
- increasing the resilience of farming systems to natural hazards;
- easy access to seed (because seed is accessible in the local market at an affordable price or because farmers can produce their own seed);
- good reception by farmers; and
- inclusion in the national variety register (in the case of improved varieties).
- The choice between traditional and improved varieties must take into consideration the advantages and inconveniences of the varieties considered, particularly regarding yield potential and farmers' preferences.



- As a general rule, in cross-pollinated crops like maize or vegetables, OPVs are more suitable for small-scale farming systems than hybrids because they maintain the properties of the variety for several seasons.
- A short cycle, drought-resistance and resistance to pests and diseases are desirable features in the context of DRR/M interventions and should be considered in particular.
- Consider in-country seed sources as an alternative to commercial seed companies or dealers. National research and extension services can also provide interesting varieties for subsistence farming. Supporting seed production by farmer groups or small-scale seed companies is another strategy for making varieties adapted to the local conditions available, and for supporting local seed markets.
- If possible, obtain results of performance trials of the selected variety over several years, either in the target area or in others with similar environmental conditions. Demonstration events help farmers to realize the benefits of new varieties.

Seed acquisition and storage

- Local seed sources should be preferred, if seed of the desired variety is available in sufficient quantity and of acceptable quality. This ensures that farmers have continuous access to seed after the intervention. Try to avoid disruption of local seed markets.

- Seed should be sufficiently dry before purchasing.
- International procurement is an option when the desired variety is not available in the country, or the seed is cheaper in other countries. It is important that the imported variety is officially approved by government staff of the host country.
- Seed tenders need to include a description of the specific crop varieties in order to ensure that the supplier will provide the crop variety specified, as well as minimum seed quality standards (QDS or the national standards). Plant health legislation should be observed in all cases.
- Seed to be purchased should comply with the highest quality standards possible. When possible, buy seed certified by a national seed laboratory and obtain the results of the quality analysis. If this is not possible, seed should be tested to determine its quality.
- When storing seeds, it is necessary to avoid high temperatures and limit air humidity in order to avoid unintended germination.
- Some seed-borne diseases can be controlled or suppressed by seed treatment during seed processing or just prior to planting. The use of seed treatment products must be managed carefully.
- Planting materials of vegetatively propagated crops have special considerations that are specific to each crop species. In general, they are more vulnerable than seeds to damage by pests and diseases and become non-viable soon after they are obtained. Avoid storing planting materials for long periods before planting.

Quality seed production by small-scale farmers

- Follow detailed crop-specific technical guidelines for seed production in each case.
- Key elements of small-scale seed production to be considered during the field stage are:
 - establishment of isolation distances between the field dedicated to seed production and fields planted with the same crop in order to maintain varietal purity;
 - choosing 'mother seed' of good quality;
 - control of pests, diseases and weeds; and
 - avoiding seed damage during harvest and threshing.
- After harvest, seed should be dried quickly. Sun-drying can normally be completed in a few days.
- Grain of good size should be selected for seed, and damaged and diseased seeds and non-crop seed materials should be removed.
- To reduce the incidence of pests and diseases, seed can be treated with organic or chemical products.
- Countries have legislation in place for the quality standards of certified seed. Certification ensures farmers that the seed they are buying is of sufficient quality.
- The FAO Quality Declared Seed System provides a seed quality assurance system that may be appropriate for small-scale seed producers that cannot meet other quality standards.

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Annexes

Annex A. FAO Technical specifications for seed procurement

1. General information

a. Requirements by FAO

- Crop common name
- Crop scientific name
- Variety name
- Total quantity requested (kg)
- Delivery date
- Varietal characteristics:
 - variety type (OPV, hybrid, self-pollinated);
 - days to maturity;
 - grain/fruit colour;
 - plant height;
 - growth habit;
 - specific resistance/tolerance to biotic factors (e.g. fungi, bacteria, viruses);
 - specific resistance/tolerance to abiotic factors (e.g. low/high temperature, frost, water-logging, low/high soil pH, etc.); and
 - list of countries/areas where the variety is successfully cultivated.

b. Offer by the bidder

- Producer company
- Country of production
- Crop common name
- Crop scientific name
- Variety name⁵
- Quantity offered (kg)
- Price (US\$)

⁵ If the variety offered is not the one required in the specifications, please provide the key varietal characteristics of the variety offered

2. Technical information

Crop common name	Technical specifications required by FAO	Actual characteristics of the seed offered (to be filled by the bidder)	Comments
Varietal purity ¹	% minimum	%	
Analytical purity ²	% minimum	%	
Germination ³	% minimum	%	
Moisture content	% maximum	%	
Seed treatment (when needed)	Product name	Product name	
Exotic diseases and pests	Absent		

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

2 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 and other crop seed.

3 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.

3. Packaging

	Technical specifications required by FAO	Actual characteristics of the seed offered (to be filled by the bidder)
Weight of containers		kg
Containers are marked with project number, variety name, germination rate, moisture content, weight, seed treatment used, date of harvest		
Packaging type		
Tags and logos		

Annex B. Summary of Quality Declared Seed Standards for selected crops

The full FAO Quality Declared Seed Standards (revision 2006) can be found through the following link: http://www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/seed_sys/quality/en/

Seed quality standards

Crop	Varietal purity (minimum %)	Analytical purity (minimum %)	Germination (minimum %)	Moisture content (maximum %)*
Beans	98	98	60	10
Groundnut	98	98	60	10
Maize	98	98	80	13
Millet	98	98	70	13
Pigeon pea	98	98	70	10
Rice	98	98	75	13
Sorghum	98	98	70	13

* Maximum moisture content recommended for safe storage. These values may vary according to local conditions, in particular with environmental relative humidity and temperature. Local standards should be applied. Varietal purity: percentage of pure seed of the specified crop variety in the seed of the crop species under consideration. Analytical purity: percentage of pure seed of the crop species in the working sample, not necessarily of the same variety.

Isolation distances

Crop	Isolation distance* (metres)	Comments
Millet (OP)	100	
Millet (H)	200	
Sorghum (OP)	100	
Sorghum (H)	100	
Maize (OP)	200	Isolation can be also achieved by 30 days difference in flowering time.
Maize (H)	200	Isolation can be also achieved by 30 days difference in flowering time.
Beans	20	
Groundnut	5	
Pigeon pea	100	

* Minimum distance with fields planted with the same crop, even when it is the same variety.

OP – open pollinated

H – hybrid







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