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Seeds in Emergencies:

A technical handbook

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This publication has been a team effort of the Seed and Plant Genetic Resources Group of the Plant Production and Protection Division (AGPMG) in collaboration with the Emergency Operations and Rehabilitation Division (TCE).

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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

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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. **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.

Farmers cleaning bean seed in Haiti

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