maintenance selection derived from the formal seed system. The resources and knowledge of farmers, and their priorities with regard to their varieties largely determine which methods are most appropriate for their conditions.

2.2 Supporting farmers' practices in seed processing and storage[*]

Niels P. Louwaars and Conny Almekinders

Post harvest operations and storage methods have strong effects on seed quality. This section introduces general aspects of these operations, such as handling, seed drying, cleaning, treatment and the effects of temperature, moisture, and insects on the potential loss of seed quality during seed storage. These aspects can be taken into account when assessing and seeking ways to support farmers' methods of seed processing and storage.

Harvesting

Harvesting should be well timed to allow quick drying of the seed, and to avoid important losses due to shattering or field infestation of storage insects (e.g. weevils in maize, bruchids in faba bean). Farmers often delay harvesting because of the peak labour needs at the end of the season, and because drying of the crop on the plants reduces the need for drying floors. Harvesting and threshing have to be done with much care to avoid damaging the seed. Threshing when the seed is over-dried may cause the seed to crack, while threshing wet seed may cause (internal) damage and create subsequent germination and vigour problems.

Processing

Processing is the first post-harvest activity in farmers' seed management. It includes activities such as handling (transporting/receiving), seed drying, cleaning and treating.

Drying

Seed should be dried quickly, but high temperatures can damage the seed. Sun-drying can normally be completed in a few days. For some crops, such as maize or sesame, special racks or cribs are used to improve the ventilation and speed up drying. If seed is dried on the floor, regular turning will improve the balanced drying of the seed lot and avoid mould growth at the bottom of the layer. In humid climates, seed drying can be a serious problem. If harvesting cannot be done during a dry season, small scale wood-fuelled dryers can be used. These require a considerable investment and

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[*] This section is adapted from Almekinders, C.J.M. and N.P. Louwaars, 1999. Farmers' seed production. New approaches and practices. London, Intermediate Technology Publications: pp. 112-118.

experience has to be obtained to avoid over-heating of the seed. The effect of high temperature is most damaging when the moisture content of the seed is high.

Cleaning

Seed cleaning has a dual purpose: it removes non-crop seed materials from the harvested material, such as straw, stones and weed seeds, thus reducing the bulk to be stored; and it also selects the seeds on the basis of physical characteristics such as size, shape, density and colour, thus removing small and shrivelled seeds and improving the seed quality.

For most crops, seed cleaning is no different to the cleaning of food grain for consumption, so that local methods for cleaning food grain are well suited for seed cleaning. Such methods include winnowing, sieving and hand-picking. Winnowing removes the light particles like straw and dust, and it can be used to remove seeds with a low density (low weight per volume: empty or 'soft' seeds). Sieving selects the seed on the basis of shape and size. Hand-picking is used to remove diseased and discoloured seeds. See Box 2.5 for an example of how seed selection and cleaning may positively affect on-farm seed production.

Box 2.5 Improving on-farm seed production of millets

An NGO operating in West Africa collected some samples of millet during a diagnostic survey in a low rainfall area. Unlike modern varieties, the traditional millet varieties were well adapted to the length of the growing season and the farmers' culinary preferences, but plant stands in the field were very variable. The collected samples were analysed. The proportion of small and damaged seeds was considerable. After removing these seeds, two samples of 200 seeds from each collected seed lot were germinated: one sample using a test called the 'rolled towel test', and the other using a calabash containing moist sand.

Results of the analysis were discussed with the farmers from whom the seed had been collected. Farmers showed an interest in carrying out the simple seed testing in a calabash filled with moist sand. Individual farmers and NGO technicians also decided to mark out a 20 x 20 m seed plot in the centre of their field where they thinned the millet to one plant per mound and removed diseased plants. At harvest they used the criteria of colour and vigour to select plants for seed which were disease free, high tillering, and had many medium to large heads. Utilizing the harvested seed and the sieving method, farmers realized a 30% yield increase in the following year. Other farmers were informed through group meetings where the individual farmers were invited to relate their experiences. In 1992, 50 farmers in 5 villages produced 850 kg of seed.

When (women) farmers pick their bean seeds just before planting, they can easily remove discolored seed due to disease infection. The chief limitation of hand-sorting seeds is, however, the time it takes. Relatively small seed-cleaning machines (0.5 t/hr) are available, but their cost and their dependence on electricity are prohibitive in many cases, and such an investment should be considered very carefully for the relatively small quantities and time period involved (compared to grain).

Treatment
After cleaning, the seed may or may not be treated, depending on the local need to control plant pests. Chemical seed treatment has become routine practice for many crop seeds in formal seed systems, and increasingly also in farmers' seed production, and is seen as offering the cheapest, safest and most efficient form of plant protection. Farmers often use chemicals in powder form, first diluted in water and then mixed with seed manually on tarpaulins using shovels. However, the main constraints for seed treatment include problems related to: availability; methods and rates of application; safety precautions; lack of adequate equipment and knowledge. Good extension programmes for seed treatment would help farmers to use chemical treatments more effectively, targeting the organisms and reducing costs and environmental pollution. It would also be helpful to provide hand operated or mobile seed cleaners, and to make sure that seed is bagged in clean bags without insects or leftover seeds from the previous harvest. To avoid mistakes, seed bags must be labelled.

Storage
The main enemies in seed storage are high temperature and moisture, which affect the maintenance of seed quality in storage. Table 2.1 gives approximate periods that seeds of a number of crops can be stored under given seed moisture conditions. Additionally, high temperature and moisture favour the development of insects, bacteria and fungi. Table 2.1 can be read as follows. When pearl millet seed with a germination percentage (viability) of 90% is stored during a rainy season (high humidity of the air, e.g. 75% and 24°C) the viability will drop to 70% within two months. If however, the seeds can be packed in a moisture-proof container after thorough drying just after harvesting, resulting in a humidity of 45% inside the bag, they will still be viable after 13 months of storage (first column). A similar result could also be obtained by reducing the storage temperature to 8°C (but this is impractical under farmers' conditions).

Storage structures and practices should also protect the seed against damage by rodents. Storage structures for food grain are often designed for the same purpose. Temperature can be difficult to manipulate, beyond such measures as avoiding stored seed being exposed to direct sunlight or to heat under a corrugated iron roof. Traditional storage structures, such as those using mud walls or underground spaces, are often well-designed and provide efficient isolation to keep temperatures moderately low.

Ideally, airtight containers are used to store well-dried seed. This is feasible for small quantities of vegetable seeds, but not for bulky field crop seeds. For vegetables, various glass jars are used, such as soda bottles sealed with candle wax. In some countries, 50 kg bags of laminated polythene/aluminium foil are available; in other areas, multi-layer polythene-lined oil drums are used. Airtight containers also solve possible insect problems because the insects suffocate as soon as the oxygen in the container is used up. This process can be speeded up by making sure the containers are well filled, or by filling any remaining space with inert materials such as sand or ashes to reduce the volume of air and restrict the movement of insects. Projects in which small low-cost aluminium tanks were designed and locally produced have successfully improved maize seed storage in Central America and other places.

Table 2.1 Storage ability of different crop seeds

Crop	*Length of safe storage at 24°C (months)*[1]		*Maximum temperature for one year storage (°C)*	
	RH=45%	*RH=75%*	*RH=45%*	*RH=75%*
Barley	19	2	27	10
Pearl millet	13	2	24	8
Rice	13	3	24	11
Wheat	6	1	20	0
Rape	28	4	29	15
Pea	37	3	32	15
Bean	67	12	37	15
Cowpea	39	4	33	14
Broad bean	70	15	36	25
Groundnut	11	1	23	-
Soybean	17	2	26	10
Cabbage	23	4	30	17
Onion	13	1	23	10
Lettuce	35	3	30	15

[1] Calculated with the 'Seedlife' programme, developed by Plant Research International, (Wageningen, the Netherlands). The following conditions are assumed: germination before storage 90%, germination after storage 70%, no insect damage.

It is extremely important that seed in airtight containers is dried very well before the container is closed, especially when the storage season is warm and humid. Some respiration will occur, thus increasing the relative humidity (RH) in the container. This problem can be reduced by placing layers of fresh charcoal in the container, separated from the seed by newspapers. The charcoal absorbs the humidity. In most cases however, seeds have to be stored in ordinary gunny bags or in bulk. In this case, good storage conditions are very important: cool, dry and free from insects or rodents.

The storage of the seed also needs to be safe from theft, and from fire and other calamities. Grain stores are generally rather well protected from rain and rodents (e.g. setting rat traps at the poles under the store). Hollowed-out gourds are sometimes inverted over hanging seed ears to provide protection against rodents. In Mali, small amounts of cucurbit seed are protected by mixing them with cattle dung or mud and plastering the cake formed onto a mud wall under a roof.

Seed is also often stored in the house for even better protection and for safety. An exceptional storage method is the hidden underground store used in some parts of Ethiopia and the Middle East. These stores have proven safe even after displacement of farmers during civil unrest. Storing seed ears in the kitchen hanging in the smoke of the fire is not only a safe place, but also keeps the seed dry and reduces insect and disease damage.

Generally, farmers have local knowledge of treatments for protecting seed during storage using ash, sand and plant extracts, for example. Mixing beans with ash is reported to reduce damage by bruchids and other insects. The ash damages the cuticle of the insects, causing them to dehydrate. Ash should be added in sufficient quantities: 25-50% by volume is recommended, and the addition of lime and diatomaceous soils improves the effectiveness of the protection.[31] Vegetable oils, such as for example soya oil, can be used as a dressing to reduce insect damage. Damage by bruchid and Acanthoscelides is reduced by mixing 5-10 ml of vegetable oil to 1 kg of beans.[31] In Northern Ghana cowpeas are mixed with shea butter oil and left in the sun as protection against bruchids.[32]

Various plants and plant extracts are used in different parts of the world, such as crushed seeds or leaves of neem, eucalyptus or lantana. It must be borne in mind however, that natural substances may be as toxic as chemical biocides and should also be treated with care. For insect control, application of chemicals can be very effective.

2.3 Community seed banks: experiences from Tigray in Ethiopia

Trygve Berg and Fetien Abay

Community Seed Banks (CSBs) were set up in Tigray in northern Ethiopia during times of war. CSBs were first developed in 1988 as a response to hardship and famine, and from 1991 they were seen as instruments of post war recovery. During the 1990s, with the situation gradually returning to normal, government services entered agricultural development. They provided farmers with 'packages' of improved seeds and fertilizers. Since then, government seed supply services have changed and the influence of the private seed sector has grown.

Traditional seed selection is in decline in many communities in Ethiopia, and not all farmers have physical or economic access to certified seed. Therefore, alternative approach towards seed supply offered by the CSB deserves careful examination.* In this section, we aim to respond to a number of questions aimed at assessing the impact of CSBs on the informal seed system. Our leading questions are: Is it possible through CSBs to revive and strengthen farmers' culture of seed selection? Could CSBs and a revived culture help to improve the quality of the seeds that farmers use? And could CSBs contribute to seed security and to improving the livelihood of the poorer households?

The beginning of seed banks: a community response

Collaboration and community action are common features of adaptation to crisis, including famine survival strategies. The idea of organizing seed banks emerged from

* See also Section 2.4 by Pitambar Shrestha and colleagues on community seed banks in Nepal.