9. Recommended seed processing and storage practices for legumes and cereals

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Introduction

Seed lots received from the field often have a high moisture content and contain trash and other inert materials, weed seeds, deteriorated and damaged seeds, off-size seeds, etc. Therefore processing is necessary to dry the seeds to a safe moisture level, to remove or reduce to the extent possible the various undesirable materials, and to have a uniform seed size and general seed treatment to upgrade the quality. In its common usage, seed processing refers to all the steps necessary for the preparation of harvested seeds for marketing: handling, drying, shelling, preconditioning, cleaning, size grading, treating, and packaging,

The primary purpose of storage is to save seeds from one season to the next. However, seed companies, seed marketers, government agencies, and farmers often find it useful or necessary to store seeds for at least 2 to 3 years, and sometimes for longer.

There are several reasons for this: seed yields and quality (germination and vigor) may be unpredictable due to growing conditions; stored seeds are a strategic reserve to guard against unfavorable weather conditions. Government policies and the market demand for certain crops may vary significantly from one year to the next. Market demand itself can be strongly influenced by media coverage of certain varieties that may quickly fall in or out of favor, depending on media exposure. Likewise, the psychological effects of poor growing conditions from the previous season may also influence market demand. The purpose here is to provide guidelines for minimizing damage to seeds and maximizing their viability and vigor from preharvest through postharvest processing. The first section deals with the general principles of processing and storage while the second gives specific processing and storage practices promoted in Nigeria.

General principles of seed processing and storage

Because seeds are routinely stored for more than one year, it is important to understand how harvesting, processing, and storage affect their longevity and vigor. Seeds are fragile living organisms, and their shelf life is affected by factors at the beginning of the plant's life cycle, such as soil nutrition. For example, if the soil is deficient in zinc, the quality of the seeds will be adversely affected. The factors that can have the most important effects on viability and vigor are harvesting, extraction, cleaning, transportation, and storage. It is easy for seeds to become damaged at any of these stages.

Harvesting: The basic rule is to allow the seeds to mature as long as possible on the plant without them or the fruit becoming diseased or overly ripe. Each type of plant has an optimal time for the seeds to be collected, but factors such as climate, weather, disease, insects, birds, or predatory mammals may require that the seeds are collected before that time. When seeds are ready to be harvested, the entire cob, panicle, or pod

will become brown and dry. During the maturation process, the ripening cob, panicle, and pod change color from green, to yellow green, to yellow, to light brown, to a darker brown, or dark gray. Ripening and maturation may be uneven within the pod, cob, or panicle, or uneven on the plant, and uneven within the stand of plants. For that reason, the pods of many plants are harvested individually. Seeds of legumes often develop a split along one side of the pod. This is the best time to collect the seeds, before the pods start to open and scatter their seeds. Confidence in knowing when to harvest comes both with experience and familiarity with different species and crops.

Threshing: After harvest, seeds are threshed to remove them from the surrounding plant material. A period of air-drying is important before seeds are threshed. Plant material should be spread out in thin layers until all layers are dry; otherwise mold, decay, and heat from decay will cause damage to the seeds. As the plant material dries, pods may split open or shed seeds. Harvested material should be stored in a well-ventilated room with low humidity. During this time you should be aware of insects, especially weevils that feed on the seeds. Plant material that is ready to be threshed should be brittle. Threshing is best done outside on a dry day. The threshing process involves the application of mechanical force using controlled pressure and a shearing motion and is accomplished by hand or by machine.

There are many different methods for threshing seeds. Plants that have pods, such as cowpea and soybean, can be threshed by placing the pods in a large feed sack, tying the bag securely shut, and then placing it on the ground where it is flailed, stepped on, jogged on, or danced on with a twisting motion. The sack is turned often to redistribute the plant material for further threshing. Care must be taken to not apply so much pressure that the seeds are abraded or broken (this is especially a concern with angular seeds). A mortar and pestle could also be used for threshing a small quantity at the farm level.

For small-scale seed production, it is often not cost-effective to purchase threshing equipment because of the small volume produced. It is difficult to locate low-cost, low-tech shredders for small-scale threshing. The options are to locate old, used equipment or to construct your own.

Seed drying: Drying is a normal part of the maturation process. Some seeds must dry down to the minimum moisture content before they can germinate. Low moisture content is a prerequisite for long-term storage, and is the most important factor affecting longevity. Seeds lose viability and vigor during processing and storage, mainly because the moisture content is high (>18%).

Seeds should be dried fairly quickly after threshing. Slow drying may result in mold growth or premature sprouting. Seeds should be spread out in thin layers and then stirred several times a day until dry. Use a polythene sheet, tarpaulin, or any hard non-stick surface as the base when drying seeds.

High levels of seed moisture cause a number of problems. Moisture increases the respiration rate, which in turn raises seed temperature. For example, in large-scale commercial storage, respiring seeds may generate enough heat to kill the seeds quickly or to even start a fire, if they have not been sufficiently dried. Small-scale growers are not likely to have such an extreme condition, but longevity will, nevertheless, be affected. Mold growth will be encouraged by moisture, damaging the seeds either slowly or

quickly, depending on the moisture content. Some molds that don't grow well at room temperature may grow well at low temperatures, causing damage to refrigerated seeds. In such a case, there may be no visual sign of damage.

Seed cleaning: It is not necessary to have expensive equipment to clean seeds for small-scale production. The majority of crop seeds can be cleaned with homemade screens. Winnowing will still be necessary to remove the smaller chaff.

Winnowing: The classic method of winnowing involves placing seeds in a wide basket and tossing the seeds and chaff into the air. The chaff is carried away by the wind. The most vexing part of the process is that the wind is always changing in velocity and direction. It can work for certain kinds of seeds, but it actually works better to use two large bowls, pouring seeds from one bowl into another bowl below, while blowing on the plant material as it falls.

This method works satisfactorily if the seeds are heavy and the chaff is very fine, and susceptible to being carried away by a gentle current of air. In any case, hand winnowing should be done, not on windy days, but when the air is calm. When dealing with large volumes or certain types of seeds, it is helpful to use mechanical equipment for winnowing.

Seed storage

Effect of temperature on seed longevity*:* The general effect of temperature on longevity is that longevity increases as temperature decreases. This is true of "orthodox" seeds: that is, most seeds that follow some general "rules of thumb" regarding longevity during their storage life. The relationship between temperature and longevity is that for each decrease in temperature of 10 ^{o}F (5.6 ^{o}C), longevity doubles. This rule applies to seeds stored between temperatures of 32 ^{o}F (0 ^{o}C) and 122 ^{o}F (50 ^{o}C). This rule assumes that the moisture content is a constant. This is a general guideline.

Subfreezing temperatures generally do not effect longevity provided the moisture content is less than 14% (because ice crystals do not form). This is the ideal way to store seeds, especially small seeds that do not require much freezer space.

Effect of moisture and humidity on seed longevity: Moisture has a greater effect than temperature. Most seeds also follow some "rules of thumb" regarding moisture and longevity. The general relationship is that for each 1% increase in seed moisture, longevity decreases by half. This rule applies to seeds with a moisture content between 5 and 13%. Above 13% moisture content, storage fungi and increased heating from seed respiration cause longevity to decline at a faster rate. Once seed moisture reaches 18 to 20%, increased respiration and the activity of microorganisms cause rapid deterioration. At 30% moisture content, most non- dormant seeds germinate.

Relationship between relative humidity and seed moisture content*:* When commercially grown seeds are to be stored, it is impractical and too costly to use desiccants to dry them for storage, unless the seeds are small and expensive. Commercial seeds are usually packaged for short-term or long-term storage under conditions of ambient humidity (unless special equipment is used). Because relative humidity has a significant effect on seed moisture content, it is important to understand the relationship between them, regardless of the type of storage conditions.

Tips on the solarization of seeds and triple bagging technique: This method of storing seeds is easily adopted, cheap to practice, and compatible with the facilities of small and large-scale farmers. Cowpea seeds stored using this method can be planted as seeds or used as grain for consumption.

Materials needed: Two plastic bags, black plastic sheet, polybag, 100 kg of seeds, Phostoxin, gloves, and mask to cover the nose and mouth.

Precautions

- Use white plastic bags to allow ease of inspection.
- Ensure that the bags are intact without perforations and strong enough to withstand damage during transactions.
- Use a good quality plastic sheet that will not melt under high light intensity.
- Use new Bagco bags; old bags may harbor bruchids or their eggs.
- Start drying cowpea when the sun has become hot; 3–4 hours continuous drying is recommended, depending on light intensity.
- Ensure that one tablet of Phostoxin in a matchbox is stuck at the center of the bag.

Procedures

- Place the black plastic sheet on the floor to retain heat and prevent seeds from taking up soil moisture.
- Place well-cleaned cowpea seeds on the plastic sheet and spread them evenly.
- Cover them with another plastic sheet that may be of any color.
- Place weights on the top sheet to prevent it from blowing away.
- Dry the seeds continuously for 3 to 4 hours.
- A sign of complete drying is when a cowpea seed will break sharply with a cracking sound when bitten between the teeth.

Heat generated under the plastic sheets is sufficient enough to kill the eggs, larvae, and adult bruchids without affecting the seeds' viability.

- Slip one of the plastic bags into the second one and place the two neatly inside the Bagco bag.
- Pour the well-dried seeds into the inner plastic bag and drop one tablet of Phostoxin wrapped in an envelope or in a matchbox when the bag is half-full
- Fill up the plastic bag with cowpea seeds, squeeze out the trapped air, and tie the bag.
- Then tie the second plastic bag and finally tie the Bagco.

When bagging 100 kg of seeds, use plastic bags with 120 kg capacity. When bagging 50 kg of seeds, use plastic bags with 70–80 kg capacity. The extra space left after the required amount of seeds will permit the mouth of the plastic bags to be tied. The use of a fiber bag may not be necessary although it protects the plastic bags against perforation.

- Periodically inspect the bags by looking through the white plastic bag.
- If there is a bruchid buildup, re-dry and place one tablet of Phostoxin.

Cowpea seeds stored by this method can be stored for more than a year without spoilage; however, it is strongly advised that regular inspection be carried out.

Important considerations in seed processing and storage

Harvest the crop as soon as it is mature to avoid field infestation, the earlier the harvest, the less the chance of infestation.

1. Dry the grains properly, making maximum use of sun and wind. Low moisture content is crucial for extended storage life.
2. Clean the seeds properly. Broken grains, dirt, and pieces of straw increase the chances of storage problems from insects and molds.
3. Select clean and healthy seeds to be retained for long-term storage.
4. Clean the stores thoroughly before filling them with new seeds.
5. Ensure dry and cool storage conditions.
6. Repair all cracks in the floor and roofs to deny places to insects.
7. Inspect the seeds frequently to detect any infestation early through sampling and sieving seeds, and shaking the bags.
8. Otherwise use airtight storage/insect-proof containers such as oil drums with perfectly fitting lids. Also plastic bags or sacks with no holes can be utilized or dry pumpkin gourds.
9. Triple bagging, using polyethylene bags, has been found to deter bruchid infestation for up to 6 months.
10. Small quantities of seeds at the farm level can be protected from bruchids by the use of minerals such as fine sand, ash, or limestone.

- 1 kg of fine sand mixed with 10 kg of cowpea seeds.
- 1 kg of wood ash mixed with 40 kg of cowpea seeds.

Vegetable oil provides some degree of protection to seeds in storage against bruchids for up to 3 months.

- Groundnut oil – 5 mL/kg of cowpea seeds.
- Neem seed oil – 3 mL/kg cowpea seeds.

Use of insecticides: Only a few insecticides can be used to control storage pests because of strict regulations concerning safety. It is important to note the following.

- The use of insecticides is a waste of money and effort when good storage practices are not implemented. Find out which insecticides to use under specific circumstances or against specific pests. Know the quantity and timing of application.
- No single insecticide is safe. Advertisements proclaiming that an insecticide is safe or nontoxic should be taken with a pinch of salt and strongly doubted.

Use insecticide only on stored products that are clean and dry, and in good storage conditions.

Never buy or use an insecticide without a label. Follow the directions for use strictly; do not use more than the recommended dose. Wear protective clothing while applying the insecticides to avoid contact.

There are two main ways to apply insecticides to control storage pests.

1. Mix the insecticide with the grain. The insect is killed when it gets in contact with the poison. This can be applied through several formulations, i.e., dust, wettable powder (WP0, and emulsifying concentrate formulation (EC0. However, such grain should *not* be consumed and, therefore, this method is strongly discouraged.

2. Fumigate—the insecticide is in a gaseous form and so penetrates the stored product.

When chemicals are used, it is very important to follow laid down safety precautions.