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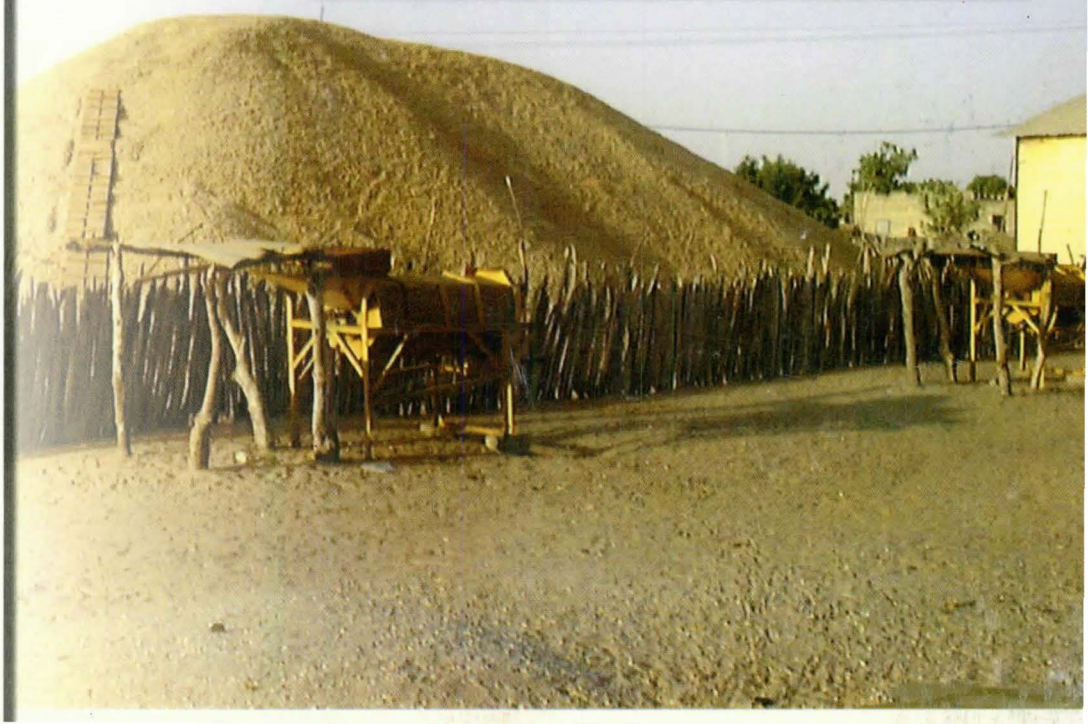
Technical Manual

Guidelines for groundnut seed production, storage and distribution for traditional farming systems

PROJET GERMPLASM ARACHIDE

GGP

Groundnut Germplasm Project



ICRISAT

International Crops Research Institute for the Semi-Arid Tropics

CIRAD

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ISRA

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Session 5

Post-harvest technology

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Introduction

Seed quality mainly depends on following appropriate handling and storage techniques for the harvested crop. Handling facilitates the selection of the best seeds while storage conditions ensure the conservation of high seed quality. Groundnut seeds are protected by a shell which acts as an excellent natural barrier protecting the seed from deteriorating agents. However, this shell should be perfectly intact in order to protect the seed. Removal of damaged pods is therefore necessary. Crop residues mixed in with the pods are often sources of contamination (insect eggs, larvae and adults, fungal spores, etc.). They also represent a pointless use of storage capacity and should be removed. Phytosanitary protection is equally critical to conservation of the overall value of the seeds.

Seed quality depends on the following compulsory steps:

– Good quality stored product

– Following recommendations for phytosanitary protection and periodic inspection especially during warehousing

– Appropriate fitting of storage facilities

Handling of the harvested crop

Groundnuts lose their seed value at maturity if they are not correctly handled. Setting up a stock of quality seeds begins with harvest at optimal pod maturity, good digging conditions (loose soil, appropriate equipment, rapid harvest) and adequate curing.

Curing

Pods with 30-40% water content cannot be stored immediately after harvesting without them overheating. Likewise, handling of newly harvest pods with seeds still adhering to the hull could provoke irreversible biological damage and partially alter the seed's ability to germinate. Curing rapidly reduces pod water content to about 15%, then gradually to 8-10%. The use of high temperatures or brutal drying is not recommended.

Pods can either be naturally or artificially cured. In arid savannah areas, uprooted groundnut plants are inverted, arranged in small heaps and left to dry for one or two days. These are then assembled into large stacks with the pods placed towards the inside preferably forming a central aeration chimney. In humid areas, the uprooted plants are dried for several days on wooden racks (stack poles) or on raised platforms before stripping. Pods are then cured in thin layers, small bags or baskets.

Under mechanized farming systems, combine harvesters collect windrows, strip and clean pods in one single operation. The pods are

Curing in stacks in the field.

then artificially cured in drying trailers. Air flow temperature should be 5-6°C above ambient temperature but should not exceed 35°C. Optimal depth varies from 0.6 to 3 meters according to pod water content and the type of curing equipment used.

Stripping - winnowing

Pods are stripped at about 2 to 6 weeks after harvesting, when the pod water content stabilizes at around 10%. This operation consists of separating the pods from the vegetative parts of the plants (vines). In traditional farming systems, manual stripping is the rule. Pods are individually detached from the vines and therefore dry very quickly stabilizing at 6-8% moisture content. The process results in a perfect quality product. Pods are separated from the vines (haulms) but are kept intact. This technique is used for the production of edible or confectionery groundnuts in order to minimize pod damage and contamination by Aspergillus flavus. However, stripping is most often done using sticks or flails. These reduce the heap of groundnut plants to mixture of chopped vines and partially broken pods that are then separated by winnowing.

Several types of mechanical combines can be used to strip groundnut windrows with less than 10% moisture content. The operation of these combines is based on the following principle. Groundnut plants are manually fed, pod first, into the combine. Stripping is achieved by friction between the stripper bars against the base of the plant and the pegs. The stripped product is evacuated across a counter stripper made up of a cylindrical grid. Large pods retained by the grid are carried along by the rotation of the combine. Pods are then stripped a second time. A built-in blower separates the trash from the finished product. The intake speed, selection of the grid, combine rotation speed and airflow speed must be regulated (by adjusting the opening of the air intake shutters).

Under mechanized farming systems, modern digging and combining equipment (high capacity machines) considerably reduce the operation time. This can lead the producer to strip an insufficiently dried product. Although this is not important in confectionery or edible groundnuts, it can damage seeds by causing microscopic lesions that alter their ability to germinate.

Seed processing

Sieving

This operation is generally done on the farm or at the collecting point. The classic sieve consists of a hexagonal or cylindrical cage made from bars. It allows part of the trash including sand, straw and broken pods to be eliminated. However, it can not eliminate pods of other varieties, empty pods (pops), partially filled or immature pods. This is the most basic cleaning operation.

Sieving.

Density separator

Groundnuts that have been stripped and winnowed using traditional methods are still highly contaminated by trash. A density

separator can be used to get good quality seeds with a high level of varietal purity, good maturity and absence of foreign bodies and empty pods (pops). This process allows improvement of seed quality during drought years and it consists of two elements:
– A shaker, equipped with sieves adapted to the treated variety that eliminate trash (sand, straw, stems) and undersized pods.
– A blower with adjustable airflow that runs along a sloping surface. Pods are separated, while falling through the air stream, according to density. Pops and partially filled pods are ejected outside whereas full pods fall into a collecting bin.

Density separator at work, Senegal.

The shaker and the blower are motorized (electric or gas engine). Gas engines must be equipped with an oil bath filter since the machine operates under rather dusty conditions. Adjustments can be made using a yield valve on the feeding tray. Adjusting the slope of the shaker sieves, the air flow valves or the lower plate of the sloping surface permits regulation of the reception opening for good pods (the smaller the opening, the greater the segregation based on pod weight).

Density separation considerably improves the quality of seeds in shell, especially after a year of drought. For Virginia type groundnuts, seed yield is increased by an average of 9%. This translates into a mean decrease of 10kg of seeds in shell per hectare.

Packaging

Pods can easily be stored in bulk following the recommendations outlined below. Storage in clean jute or woven polyethylene fiber bags ensures the best protection of groundnuts and facilitates manipulation of stocks (manual or palletized). Groundnut seeds must only be stored in bags or drums according to recommendations presented in the following chapter. Each bag must be properly labeled. Labels must show batch origin, year, level of multiplication, seed weight and eventual phytosanitary treatments.

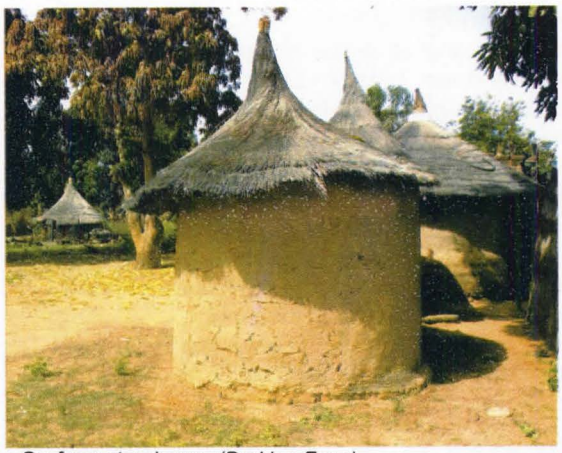
Seed storage and conservation

Groundnut can either be shelled or stored in shell (improved seeds, communal stocks, buffer stocks of shelling plants).

– Seeds in shell are less exposed to different deteriorating agents and can be conserved quite well for short periods. When stored in heaps, pods must be treated with layers of insecticide followed by a final overall treatment. This requires extensive waterproof storage areas or high capacity warehouses (600-800 tons). Handling costs are proportionally high and could be minimized by only storing properly cleaned, good quality batches.

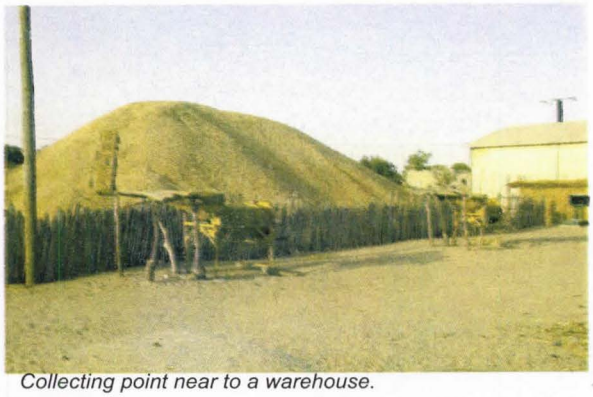
– Shelled groundnuts are fragile and are exposed to various agents that cause physical, chemical and biological deterioration. They rapidly lose their seed value when stored under natural conditions, especially in tropical areas. The height of stacked bags should be limited to avoid crushing the seeds. Shelling methods strongly influence seed quality (see chapter on industrial seed processing).

On-farm storage of pods



On-farm storehouse (Burkina Faso).

Farmers only keep limited quantities of groundnuts because of financial and logistical reasons. They rarely distinguish between seed groundnuts and those destined for sale (or their own consumption). Protective insecticides are rarely used since farmers consume some of the groundnuts themselves. In humid tropical areas with two rainy seasons, farmers store their seeds in a ventilated area where they fumigate them. This storage method is absolutely inappropriate and generally leads to considerable losses caused by insects and fungi (more than 30%). Farmers can equally use communal facilities for storing large quantities. However, co-management is often problematic for three reasons: contamination of the entire stock by poor quality batches, lack of confidentiality and restrictions to seed withdrawals to satisfy the farmer's financial needs. Groundnut storage is often conducted by salespeople who are not concerned about quality in general, and even less so by the specific requirements needed for conserving seed quality.



Collecting point near to a warehouse.

Collective or industrial storage

Pods must be stored according to well-defined technical recommendations in order to provide a quality product and to ensure profitability.

Groundnuts should be stored as follows:
– Collect quality raw material (well filled mature pods), clean, free from visible insect damage, well cured (6-8% water content)
– Clean storage facilities
– Treat storage facilities and seeds (paragraph 5)
– Check seeds regularly during storage (every 15 days or once a month according to storage period)

Storage of shelled groundnuts

This system is rarely used on farms since shelled groundnuts are more fragile and require expensive, hermetically sealed packaging (plastic or metallic drums). After shelling, specific procedures must be followed in order to ensure seed quality. Two processes are recommended: refrigerated storage and controlled or modified atmosphere storage.

Refrigerated storage

This system is simple, tried and tested and results in excellent long-term storage (more than 3 years). However there are certain technical and financial constraints :

– The stock is physically blocked in the store during the entire storage period
– Seeds must all be unpacked at one time and certain precautions must be taken. For example, the temperature must be increased gradually, especially during the rainy season and seeds must be rapidly used (within a few weeks) before they lose their viability
– The cost increases sharply with storage time because energy consumption is high.

Controlled or modified atmosphere storage

Seeds are placed and maintained in anoxic conditions in either a complete vacuum or in a modified atmosphere (vacuum replaced with Nitrogen or Carbon dioxide gas).

Seeds can be maintained under these conditions for medium term periods (18-24 months) by using extruded multi-layered packets that have a high mechanical resistance and are impermeable to gases. A package thickness of 60µm is adequate for small quantities of up to 1 kg (e.g. storage of collection samples) however a thickness of 90µm is recommended for larger quantities (1-10 kg). This is especially recommended for vacuum packaging where stretching is an important consideration. Controlled atmosphere storage is not only cheaper than refrigerated storage but there are also no chemical residues on the seeds (seeds can be untreated). Seeds are therefore not hazardous and can be used without special protection or authorization. Resistance or tolerance to pesticides can also be avoided.

Vacuum packager.

Anoxia eradicates insect pests especially the groundnut seed beetle. Trials were conducted in Senegal on seeds that were artificially infested with C. serratus and packaged under vacuum for 1-42 days (complete vacuum at 0.26 atm, compensated vacuum (0.79 atm) with technical Nitrogen (98% N^2) or with additional CO^2). In all cases, beetles were completely eradicated in less than 21 days.

Seeds packaged with Nitrogen, either with or without addition of CO^2 under a slight vacuum are completely viable after 18 months of storage at ambient temperature. Seeds must be stored in a well-ventilated area and protected from rodents that could damage the bags. Leakage of air into the packets is the main technical problem. In order to avoid this, the sealing machine must be properly adjusted (welding quality), the bags must be of good quality and particular care must be taken during handling. The seed value of the product depends on its initial quality and careful compliance with specifically adapted curing and shelling techniques.

Some technical elements of the industrial preparation of ready-to-use groundnut seeds

An experiment was conducted in Senegal on the use of ready-to-use coated groundnut seeds to improve financial and technical management at all stages of the supply chain. All the difficulties associated with managing seeds in shell are avoided using this process:
– Minimize the volume to be stored
– Avoid losses and cheating caused by contaminants (sand, soil, other waste, etc.)
– Eliminate bad farmer practices (partial self-consumption of seeds, absence of insecticide treatment, incorrect insecticide application)

Although coating technology offers many advantages, it requires careful inspection and control of industrial handling, packaging and storage of the final product (annex 12).

Mechanical shelling

This first step of the manufacturing process is critical to product quality. Mechanical shelling is relatively brutal and can cause severe damage to the seeds (splitting, cracking). Operator expertise is fundamental to reducing the risks of visible and invisible lesions.

Operating principle

A mechanical sheller is equipped with a head made from perforated or barred semi-cylindrical grills, which form a cage. Hulls are spread and broken by a rotor inside the cage. A pre-sorting is done by a cleaning system (sieving and blowing), designed to eliminate or collect by-products, broken or immature groundnuts. A grading shaker that allows unshelled groundnuts to be separated from whole and broken groundnuts completes the operation.

Influence of batch quality on shelling

The level of broken kernels increases when immature pods are harvested, when groundnuts have been beaten with a stick, mechanically (+10%), or too late (+5% per month). This also occurs when pod moisture content of is less than 5-6% (in the Sahel pod moisture content can fall below 3%).

Importance of optimizing adjustments

For a batch of a given quality, the yield of whole kernels is significantly decreased if the grill's hole size is smaller than the groundnuts, if the rotor speed is excessive and the feeding rate of the machine is too high (a feeding regulator may be required).

These requirements slow shelling speed and allow a judicious choice to be made between yield and quality. Since the pod size for each batch may be relatively heterogeneous, pre-calibration of the groundnuts is recommended in order to optimize the yield of whole seeds.

Electronic color sorting

Color sorters use color-based systems pre-set by the user. This principle gives an excellent reproducibility of the results, with a high yield for both visible and invisible wavelengths.

The sorter consists of the following equipment:
– A vibrating electromagnetic hopper for precise feeding of the system;
– A steeply inclined descending chute aligning, directing and accelerating the seeds;
– An examination field composed of fluorescent lights, electronic optics opposite to reference screens;
– Complex computerized equipment for data collection and analysis;
– An ejector that uses short blasts of compressed air to blow the offending kernel (darker or lighter than the variety standard) out of the stream of groundnuts.

Wavelengths reflected by each object arriving in the examination field are captured by the optical systems and transmitted to photoreceptors that transform them into electric signals. These are then analyzed by the computerized equipment. When a defective groundnut is detected it is eliminated by a blast of compressed air.

The use of clean, standard sized groundnuts (for adjusting sorting rate and ejection speed) as well as a suitable environment (stable power supply, availability of filtered and cooled compressed air and a clean area with air conditioning) are critical for successful color sorting.

Seed coating

The typical coating system consists of:
– A feeding tray regulating the flow of seeds to treat
– A treatment feeder to deliver the appropriate rate of chemical
– A performing system that compiles the flow of seeds and chemical in order to ensure proper treatment rate (mechanic or electronic control)
– A mixing drum to homogenize the distribution of the treatment to all the seeds (this is equivalent to a draining or pre-drying system)
– A conveyor belt to transfer the seeds to the weighing-packaging area.

The principles for an optimized use of the system are:
– Excellent quality seeds (seed value and integrity)
– Regular seed feeding rate
– Precise chemical feeding (fungicide or fungicide + insecticide)
– Reliable and rapid control system for seed feeding
– Chemical treatment adapted to the process (stable active ingredients, slow decanting, good coating ability) and to the local soil microflora

Phytosanitary protection of stored seeds

Control of storage pests is of critical importance. This is even more so in tropical countries since agricultural production does not always meet demand. Local environmental conditions are also favorable to pest development.

Groundnuts characteristically form their pods in the soil and are therefore vulnerable to attack by pests such as termites (Isoptera) and millipedes (Myrapoda and Diplopoda). These can cause yield losses and reduce the quality of the harvested crop by damaging hulls. These lesions become gateways for fungal infection, notably *Aspergillus flavus*, the species responsible for aflatoxin contamination.

Severe attack by seed bugs *(Aphanus sordidus*, Heteroptera: Lygaeidae) are sometimes observed on drying pods in the fields. The nymphs and adults feed by making fine perforations in the hulls. This causes very little visible damage but causes seed desiccation and greatly reduces seed viability.

Damage caused by Groundnut seed beetle larvae.

Emerging adult beetle.

Rodents also cause field losses to the drying crop. They are of variable diversity and importance, however there are two main species: one diurnal species, the Striped Ground Squirrel *(Xerius erythropus)* and one nocturnal *(Cricetemys gambianus)*.

The principal stored product pests, the seed bug (Heteroptera: Lygaeidae) and the groundnut seed beetle *(Caryedon cerratus)* can cause significant damage (Annex 13). Other insects, particularly Khapra beetles *(Trogoderma granarium* E.), as well as flour beetles, *Tribolium castaneum* H. and *T. confusum* are also important, especially on shelled groundnuts.

The Groundnut Seed Beetle is the most formidable long-term storage pest (Gillier & Brockelée-Morovan, 1979). The larva develops inside the pods and is therefore protected from insecticidal dusts and sprays.

However, local farmers tolerate damage caused by this pest, as long as losses are not spectacular. The detection of seed beetle damage and hence the decision to apply treatment is sometime too late. The possibility of future attack is unrecognized by farmers since they are unaware of the multivoltine life history of certain pests. Farmers tolerate a certain level of damage since they accept the idea that "the pests take their share of the harvest!" Such fatalism is an example of the ambiguous relationship that farmers have with their environment.

Treatment methods: insect control

Contact treatments

Future stacking sites must be treated with an insecticidal dust before windrows and stacks are formed for drying the groundnuts. A peripheral band should also be treated to protect the site. Groundnuts are thus protected against termites and seed bugs. Storage areas, containers, drums, bags and storage equipment (conveyors, etc.) must be treated before storing groundnuts. Cleaning these areas can be followed by fumigation or spraying with insecticides. Pesticides are applied using a sandwich technique. Seeds are dusted during bagging, and then an insecticidal dust is applied between each layer of bags.

Organophosphates are contact insecticides currently used. Bromophos (500g of 2% dust/ton) or idofenphos (1000g of 2% dust/ton) are the most commonly used products. Other available products with long residual activity include:

Organophosphates: ethyl-pyrimiphos (Actellic®), methyl-chlorpyriphos (Reldan®). Their residual activity is low in open air but exceeds 6 months on stored seeds protected from light.

Synthetic pyrethroids: Deltamethrine (K. othrine®).

Contact insecticides ensure good protection against insects once groundnuts are not previously infested. For this reason, preventive fumigation of seed groundnuts must be carried out.

Fumigation

Groundnut seeds (sorted pods or kernels) can be treated under airtight plastic tarpaulins, hermetically sealed silos or warehouses in a fumigant saturated atmosphere. Groundnuts are currently fumigated in pyramidal heaps under plastic tarpaulins. Bags are arranged to form a pyramid that is slightly smaller than the tarpaulin. The base is sealed with a row of sandbags.

Methyl bromide (CH_3Br), long used for fumigation, is now prohibited by international legislation since it contributes to the greenhouse effect. This product, used in gaseous form, has an instantaneous impact on pest, eradicating all developmental stages (eggs, larva, and adults). Hydrogen phosphide (PH_3), the only remaining authorized fumigant, is available in tablet form. It's

release is much slower than methyl bromide and it's use requires absolute adherence to manufacture's recommendations in order for it to be equally effective. For this reason, under the arid conditions in the Sahel, a humid environment must be created under the fumigation tarpaulin. Small, water-filled cups or dampened bags are placed on the surface of the heap of groundnuts being treated. This ensures a rapid gas release that guarantees immediate eradication of the pest.

Fumig... and storage worksite.

The gas is produced from the breakdown of aluminium phosphide tablets (Phostoxin). Hydrogen phosphide, also known as phosphine gas, is obtained when its precursors (aluminium or magnesium phosphide) are exposed to humid conditions. Tablets must be placed on small saucers in order to recuperate powdery residues that still contain traces of aluminium phosphide. Successful fumigation depends on several factors. The most important are: ambient moisture, fumigant dose and fumigation duration. Fumigant dose can be reduced in airtight treatment areas at high temperature.

Groundnuts have relatively high absorption rates for hydrogen phosphide: 50% and 80% respectively for shelled and unshelled groundnuts with a 5-day fumigation at 25°C[1]. In practice, a 3-4 days treatment with a dose of $2g/m^3$ and $3g/m^3$ PH_3 can be used respectively for shelled and unshelled groundnuts stored under tarpaulin or in fairly airtight warehouse (considering a 50% loss coefficient).

Stored groundnuts must be regularly checked for sanitary problems, and a seed sample should be analyzed at 3-week intervals to ensure good conservation and eventually implement corrective measures.

Physical and mechanical methods

These low technology methods are cheap, effective and readily available to farmers. Several techniques are used, depending on the area.

- Groundnut pods are mixed with powdered minerals (ashes, sand, etc.) that act as abrasives or physical barriers,
- Hermetically sealed containers in which anoxic conditions limit insect development,
- Temperatures are below (<5°C) or above (>40-45°C) the optima for insect development,
- Solarization of groundnuts under plastic or polyethylene mulching (thermosolar treatments) which greatly affect Groundnut Seed Beetles. Precautions must be taken to avoid deterioration of seed viability.

1. Laboratoire Denrées Stockées, 33150 Ceno. France

Conclusions on control methods

There are several reasons for the relative failure of recommended control methods for the groundnut seed beetle.

– Pre-infestation in the field is not taken into consideration, especially by farmers. Precautions are not taken during harvest when groundnuts are left to dry in open fields. Pods are exposed to beetles soon after digging, 2-3 days after windrow formation (S. Ndiaye, 1991[2]) especially in fields closest to wild host plants like *Tamarindus indica, Pilisotigma reticulatum, Cassia sieberiana* and *Bauhnia rufens.* The infestation increases with prolonged exposure in the field and damage can be severe (maximum of 48 to 80% with means of 0.83 to 1.95 eggs per pod).

– The importance of hygiene in the storage area is not always taken into account (careful cleaning, treatment of partitions and packaging material before use, incorporation of insecticides).

– Several factors have been identified at the farmer level. These include the use of low-penetration formulations (generally powders), late treatment of the stored product along with a certain lack of knowledge about the dynamics of seed beetle contamination, concentration of control capacity in large commercial stocks or in oil mills etc.

– The implementation of good pest control practices results in successful control. of Groundnut Seed Beetle Unfortunately, recommendations are not always followed. Low dosages are applied and some of the product (Phostoxin® powder) is resold on the informal market. This has now become increasingly important since, unlike methyl bromide, the use of Phostoxin® does not require specially trained staff.

Finally, the abusive designation of the insect as "a stored product pest" must be avoided since this obscures the importance of other aspects of the insect's live cycle.

An integrated approach to seed beetle control must be taken, that is, one that combines several complementary methods and avoids dependence on chemicals. The beetle's life cycle must also be precisely understood, in order to identify the initial infestation period and detect when the pest is most accessible and vulnerable. This is particularly important before pods and kernels become infested.

Many species of seed beetle parasitoids have been identified (Gagnepain & Rasplus, 1989; Delobel, 1989). These include Pteromalidae, Chalcididae and Trichogramma (Hymenoptera). However, they have not yet been effectively used in a control program. Farmers have used several plant products for seed beetle control. These include leaves of Boscia senegalensis, bark fragments of *Faidherbia albida,* and leaves or oil of *Azadirachta indica* (neem). These have not always proven to be effective.

Discussion

During the course of this session on post-harvest technology, discussions focused primarily on seed quality. Different techniques for conserving seed quality were described. These included treatment and handling of the harvested crop (curing, winnowing, sieving, sorting and bagging), seed storage and preservation, phytosanitary protection and analysis of seed quality.

In the sub-region, mechanical equipment for handling the crop is essentially used by research institutions and a few organized professional seed producers. On traditional farms, these

2. *Saliou NDIAYE, 1991. La bruche de l'arachide dans un agrosystème du centre-ouest du Sénégal : contribution à l'étude de la contamination en plein champ et dans les stocks de l'arachide (*Arachis hypogaea L.) *par* Caryedon serratus *(OL.)* (Coleoptera, Bruchidae) *; Rôle des légumineuses hôtes sauvages dans le cycle de cette bruche. Thèse (nouv. Régim) Université de Pau et des Pays de l'Adour, 96 p.*

procedures are more or less manual and differ slightly, depending on the area and type of cultivation.

Curing - Winnowing
Only curing methods for arid tropical zones were described since techniques used in humid or irrigated areas are very different (pods are exposed to the sun in Nigeria or scattered on the soil in Guinea). Most importantly, these techniques are adapted to maintaining the quality of the harvested product.

Sieving - Sorting
These cleaning techniques, especially sorting, are very important in seed production. Immature, malformed, unfilled or mouldy pods (often aflatoxin contaminated) are eliminated by this process. This procedure therefore has a direct impact on seed quality.

Storage - Conservation
In the sub-region, mainly pods are stored. In most countries seeds are stored by the individual (storage in lofts). Seeds can also be communally kept in village stores (as in Mali, Mauritania, Guinea and Senegal). In Nigeria, large storage structures that are directly linked to the national seed production service exist alongside storage by individuals.

Phytosanitary protection of stores
Scale is a very important concept for the phytosanitary protection of stores. Traditional or biological techniques, often used for treating small quantities of seeds (dozens or even hundreds of kilos) cannot be applied to large-scale storage facilities. Pesticides must be used for fumigating stocks and for sterilizing equipment when storing several tons.

Storage is a critical step in the production of quality seeds. This point was brought to the forefront during this session. Proper storage techniques allow seed quality to be conserved from the time the crop is harvested until the seeds are sown the following year.

In Niger, there are so many risks and constraints, that farmers do not hesitate to get rid of their seeds as quickly as possible. However, in countries where farmers follow technical recommendations and industry standards, the value of certified seeds is well recognized, and farmers generally demand the intervention of seed inspection and certification services.

Analysis of seed quality
The health of stored seeds is generally determined by germination and purity tests. These methods of seed quality analysis are well known and used throughout the region, especially at the research level. However, there are few certification laboratories that are actually functional. Although the concept of seed quality is well received and recognized by farmers, standards are often set within the context of official or national seed production systems. Once outside of this context, quality is generally left to the judgement of the farmers.

In conclusion, storage is a critical step for seed producers since the following parameters must be taken into account at this stage:
– Availability of equipment
– Availability of phytosanitary products
– Availability of training and/or information to farmers
– Frequency of inspection by qualified services
– Structures and types of storage available (individual, communal, industrial...)

As previously stated for seed multiplication programs, following recommended post harvest practices depend on the type of demand. This consequently leads to the production of seeds with several different quality grades