Session 4

Technical basis for the production of groundnut seeds

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1. Cirad/GGP, BP 6478, Dakar-Etoile, Sénégal.
2. ISRA/UPSE, BP 53, CNRA Bambey, Sénégal.
3. USAID/Peace Corps, BP 2534, Dakar, Sénégal.
4. ISRA/UPSE, BP 53 Cnra Bambeỷ, Sénégal.
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Introduction

One of the most efficient means for the African farmer to improve the productivity of his/her farm is by the use of high quality groundnut seed. Organizing high quality seed production and distribution is critical to the implementation of any development plan. This precondition also applies to other factors that affect productivity. Pod and grain size of a specific variety is an important parameter for determining seed value. The crop should be grown under appropriate conditions of climate and soil fertility to ensure good pod formation, filling, and seed maturity. Cultivation techniques must be perfectly mastered in order for the plant to attain its full potential and ensure quality production. These standards are fundamental for producers who want to sign up for a national multiplication program. The farmer must also accept controls and conform to production certification standards (session 3).

Seed physiology

Planting non-viable seeds that cannot germinate and therefore ensure a good harvest, is the farmer's greatest risk. Determining seed crop value is the ultimate objective of any analysis. However, parameters that determine seed quality may be prioritized differently, depending on the user. There are recommended analytical methods based on standardized international seed trading guidelines. These have been ratified within the framework of the International Seed Testing Association (ISTA).

Germination

Germination is defined as the appearance and development of the embryo, to form the essential organs of the seedling. The seed's ability to produce a normal seedling under favorable conditions can be determined by examining these organs (annex 15).

The mature groundnut seed is made up of an embryo comprised of two cotyledons, a short hypocotyl, the plumule and the primary root. The plumule is formed by a central axis and the two cotyledon axes. It already contains nine embryonic leaves. These essential organs originate from tissue differentiation during the embryo's development inside the seed.

Viable seeds begin germinating when placed in a favorable environment (temperature, moisture, and oxygen). Germination takes place in several stages:
– Imbibition
– activation of enzymes
– growth of the embryo
– rupture of the testa
– elongation and emergence of the radicle
– growth of the terminal bud and embryonic axis

Imbibition is based on the seed's chemical composition, water availability in its environment and the permeability of the testa. Protein-rich seeds need to imbibe 2-5 times their dry weight in water to initiate germination. This is relatively high when compared to certain sugar-rich cereal species. These need to absorb only one and a half to twice their dry weight in water. In order to germinate, legumes and cotton need a minimum water content of 50-55% whereas cereals need 30-35% which is close to the observed water content at physiological maturity.

Water activates the enzymes responsible for hydrolysis of nutritional reserves (lipids, sugars and proteins). It is essential for transport and utilization of the simplest and most mobile components (glucose, amino acids, etc.) by the growing embryonic axis. Enzymes catalyze the reaction needed for the synthesis of new material required for tissue differentiation and growth of the embryo.

Germination in peanuts is epigeal. The cotyledons and the sprout are carried above the soil by the elongating hypocotyl. Seed viability can be determined by a germination test. Four repetitions of 100 seeds or 8 repetitions of 50 seeds (a total of 400 seeds are used. Seeds are equally spaced on a moist substrate then placed in an incubator at 30°C and 90% RH. Seeds are evaluated after 5 days (germinative vigor) or 10 days (viability). They are also classified as normal seedlings, abnormal seedlings and ungerminated seeds.

Dormancy and techniques for breaking dormancy

Dormancy is a natural phenomenon in the plant kingdom. It is defined as the inability of newly harvested seeds to continue their development under favorable environmental conditions (temperature and humidity). Generally, dormancy is an absence or a significant reduction in seed viability, even under favorable conditions. Dormancy is an adaptation that allows plants to survive particular climatic conditions. Seed germination is spread over time since the intensity of dormancy varies within a seed population.

Natural factors or climatic changes can break dormancy. It is absent in Spanish and Valencia type groundnut or is naturally broken several weeks after seed maturity. It can cause pre-harvest germination in the field when harvesting is delayed and the soil is still moist (irrigation, end of season rains) and even during storage in unseasonably wet periods. This type of unwanted germination considerably reduces seed yield and quality; such seeds are usually downgraded and used for oil production. Virginia type groundnuts have a longer dormancy of 4 months or more.

Endogenous metabolic inhibitors cause dormancy in groundnuts. These are generally enzymes that block hydrolysis of nutrient reserves and nutrient transport to the embryo. The synthesis of new material is thereby inhibited.

Previous work has shown that products such as Ethephon® containing ethylene (3.5ppm) induce excellent germination. Ethephon® can also be used to break dormancy in groundnuts. Ethephon® or ethrel, originally a growth regulator, progressively decomposes into mainly ethylene as well as several other substances. It is available in liquid or powder form. The powder is added to the fungicide-insecticide mixture and the liquid is sprayed onto untreated seeds. Heat treatments can also break dormancy (40-45°C for 15 days) but this long, slow treatment is not very convenient.

Technical practices

Under low rainfall conditions, seeds should be produced in the most suitable areas in order to maximize potential production. This also minimizes transport and marketing costs.

Soil selection

Groundnuts prefer light soils that facilitate penetration of the gynophores (pegs) after pollination, and easy digging without pod loss. Groundnut requires well drained sandy loams and must not be sown in shallow soils exposed to erosion. Groundnut plants are sensitive to salinity, a little sensitive to alkaline soils but they prefer soil with a neutral pH. High soil acidity (pH<5) could induce magnesium or aluminium toxicity. In this type of soil calcium must be added to maintain the pH above 6.

Climatic conditions

The optimum temperatures for growing groundnuts range from 25°C to 35°C. Cooler temperatures, especially at night, result in a longer growth cycle. Groundnuts are slightly sensitive to photoperiod. The groundnut is often classified as drought resistant with performances that make it one of the main crops cultivated in dry tropical areas. However, good performance is strongly linked to adequate soil water content at sowing time, followed by well distributed rainfall. The life cycle of the groundnut can be divided into 4 phases that correspond to variable water requirements. For a 90-day variety grown under sub-Saharan conditions, the requirements are as follows:

- Vegetative growth (0-20d): 3.5mm/d
- Flowering (21-40d): 5.2mm/d
- Pod formation and filling (41-70d): 4.4mm/d
- Maturation (71-90d): 3.9mm/d

Early small-seeded groundnut varieties require 300-500mm of rainfall and late large-seeded varieties 1000-1200mm.

Field isolation

Groundnuts are self-pollinating and therefore do not require isolation. However, different varieties must be placed 5-10 m apart to avoid mixing during harvesting and stripping.

Crop rotation

Groundnut is very sensitive to the preceding crop and must not be cultivated for several consecutive years. A well adapted rotation program could improve the efficiency of fertilizer use, soil structure, weed and volunteer plant control, and reduce pest pressure. Nematodes and certain foliar diseases transmitted by soil-borne pathogens can be partially controlled with an appropriate rotation program.

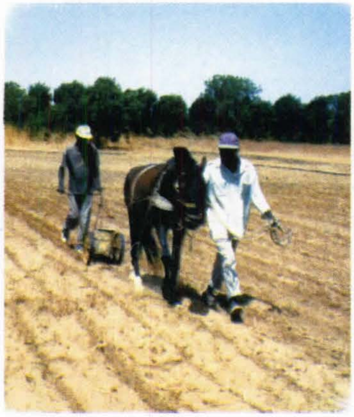
Soil preparation

In semiarid regions, removal of crop residues that spread diseases and harbor pests is a priority activity. For light soils, this type of cleaning followed by a shallow raking is often done after the first light rains. This eliminates early weeds and breaks up the soil surface where seeds are sown soon after the first substantial rainfall. In wetter areas or with heavier soils, fields must be plowed at the beginning of the cycle to suppress weeds and break up the soil, which must then be refined by harrowing. With this soil type, raised-beds are often made to limit run-off or plant asphyxia by standing water. The beds can be wide and flattened on the top in order to accommodate two rows per bed.

Sowing

Before sowing, seeds must be carefully prepared. The preparation depends on the way they were stored. When stored in shell, groundnuts must be preferably hand-shelled and sorted in order to eliminate skinned, immature, moldy, and shrunken seeds. Seeds are then treated with an insecticide/fungicide mixture to protect them against insects and fungi during germination. The most common are: carbofuran[1], heptachlor[1], captafol[2], thiram[2], benomyl[2], captan[2], carbendazim[2], etc. depending on the regulations of the country where they are used. A coating technique for ready-to-use seeds is presented in session 5.

1. *Insecticides.*
2. *Fungicides*



Sowing with a single-row planter.

Planting date is linked to rainfall distribution in the area and the length of the variety growth cycle. Soil moisture must be sufficient to guarantee good germination. Seeds must not be sown immediately after heavy rains since they imbibe too much water which causes rotting. This also results in excessive soil compaction, which may hinder germination.

Spacing depends on the growth habit and the variety: 10 to 20cm between plants, and 40 to 60cm between rows. Planting density is also affected by water availability, and cultivation methods (flat or raised beds, manual or mechanized). In addition, the spacing must allow plants to cover the soil within 50 days ensuring better weed control and rational water use. In rain-fed crops, density varies between 110,000 (Virginia) and 170,000 (Spanish) plants per hectare. This can be as high as 250,000 plants/ha under irrigated conditions. The weight of seeds in shell required to sow one hectare is called the seeding rate (SR). This depends on varietal characteristics, seed quality and planting density. The SR is calculated as follows:

$$SR = \frac{\text{Density (plants/ha) X Weight 100 seeds (g)}}{\text{10 X Seed viability (\%) X Shelling percentage (\%)}}$$

With manual sowing, individual seeds are sown 3-5cm deep. Mechanized sowing is widely practiced in Senegal. This is done using a single-row planter, generally drawn by a horse or donkey. In this way, one hectare can be sown in 8 hours. A disk adapted to the seed size, turns inside of a hopper and regularly dispenses the seeds into a furrow opened by the planter blade. A weighted rear wheel then closes the furrow.

Fertilization

A reasonable level of organic matter must be maintained in the light, weakly structured, tropical soils where groundnuts are grown. The groundnut plant has an extensive root system that allows it to explore a large volume of soil and therefore benefit from organic manure residues from the preceding crop (cereal). Groundnut can be cultivated with an N-P-K type mineral fertilizer. Calcium must be added to slightly acidic soils to correct the pH and improve the technical quality of the seeds. Calcium deficiency leads to a high percentage of aborted seeds (empty pods or "pops") and improperly filled pods. Calcium is barely translocated across the leaves therefore it must be applied near to the fruiting zone (as a side dressing). This must be done at the beginning of pod formation in order to be directly absorbed by the pegs and the young developing pods. The quantity of fertilizer needed to maintain a seed-producing field depends on soil type and varies between 200 to 600kg/ha of gypsum for large-seeded varieties.

Crop maintenance

Hoeing - Weeding

Early weeding affects future crop growth since it allows better infiltration of rainwater, controls early weeds and therefore prevents competition for water, a scarce resource in sub-Saharan areas.

Hoeing facilitates careful removal of volunteer groundnut plants from previous crops and incorporation of chemical fertilizers applied after sowing. Weeding can either be manual or mechanical. The first hoeing is generally followed by one or two others, along with manual weeding of the row. The crop must completely cover the soil from 50 to 60 days, thereby limiting weed growth. Chemical weed control is uncommon, however, application of a pre-emergence herbicide would result in possible savings in time and labor, which could be better spent on other work. This technique also requires specialized equipment as well as knowledge of chemical products and their application methods.

Culling out off-type plants

This consists of manual removal of plants of other varieties present in the field. Depending on the degree of contamination a field can be retained or rejected for seed production. In Senegal, fields of breeder and foundation seed should have less than one off-type in 1000 and those of certified seeds, one in 200. Applied standards for varietal purity of groundnut seeds are as follows; a minimum purity of 98% for level 1 seeds, and 95% for level 2 seeds (Figure 1 - session 2). Regular field checks allow elimination of foreign plants based on phenotypic characteristics of the cultivated variety. Culling out off-type plants in seed fields maintains the genetic quality and can only be effective if checks are rigorously continued throughout downstream operations (removal of foreign pods during shelling, cleaning of equipment, warehouses and packaging material).

Inspecting a seed producing field.

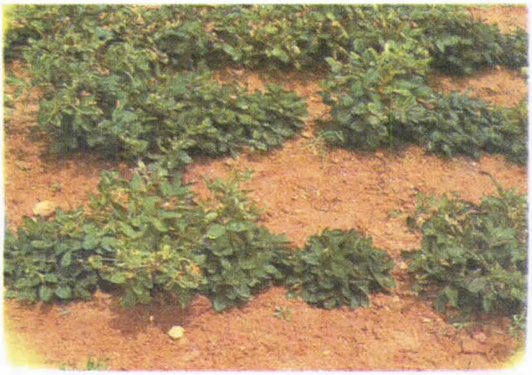
Irrigation

Although groundnut is a hardy plant, high yield seed production can be guaranteed using irrigation, especially for first generations. Irrigation also allows off-season (outside of the rainy season) groundnut production which accelerates seed multiplication in the Sahel. Quality production is ensured using an irrigation program adapted to crop demand at each developmental stage. Different irrigation methods can be used including overhead (sprinkler, etc.), drip and furrow irrigation. The latter is the most commonly used in West Africa but does not always ensure homogenous water distribution, especially in large fields. Telethermometry is useful tool for managing irrigation systems. It links water demand to the temperature of the canopy and facilitates optimum water supply, and thereby avoids wastage of water resources. Individual or communal irrigated fields must be privileged partners for seed production since input usage (fertilizer, lime, phytosanitary protection) recommended for seed production is rewarded by high yield and quality.

Phytosanitary protection

Groundnuts are exposed to pest and disease attack that can cause deterioration of the quality of the product and lead to significant losses. Some of the most common diseases are as follows:

Foliar diseases



Groundnut rosette.

Groundnut rosette is a disease caused by a virus complex (combination of several viruses) transmitted by an aphid *Aphis craccivora* Koch. There are 3 forms of the disease: chlorotic, mosaic or green. The green form occurs mainly in West Africa. Infected plants are stunted and production is greatly reduced. The disease can be controlled using resistant varieties along with specific cultural practices (early, high density sowing). Chemical control is often difficult and not economically feasible.

Peanut Clump Virus (PCV) is a soil and seed borne disease. Continuous culture favors its development. Infected plants are stunted and have symptoms such as mottling, mosaic, and chlorotic rings on the leaves. Such plants must be removed and contaminated fields must be excluded from any seed multiplication program.

Early leaf spot.

Peanut Mottle Virus (PMV) is a viral disease. Symptoms include dark green irregular patches on young leaves. These are not easily seen on older leaves but a fine mottling can be observed with backlighting.

Early and late leaf spot are diseases caused by fungi that commonly occur in groundnuts. Early leaf spot, *Cercospora arachidicola,* causes dark brown necrotic lesions surrounded by a chlorotic halo on the upper leaf surface. Late leaf spot, *Phaeoisariopis personata,* causes almost circular necrotic lesions that are very dark brown. Spores are produced on the leaf under-surface. At high disease incidence, chlorotic infected foliage prematurely senesces and falls. Although chemical control is effective, it is not very profitable since several treatments are required during the vegetative growth phase of the crop. Farmers also have to try to control groundnut rust at the same time.

Groundnut rust *(Puccinia arachids)* is a widespread fungal disease. Orange pustules appear on the lower leaf surface and necrotic lesions can occur on any aerial plant part. Unlike leaf spots, rust causes necrotic leaves to dry out but remain attached to the plant. Crop rotation is recommended in order to limit infestation, like for leaf spots.

Groundnut rust.

Other foliar diseases can also be observed. These include *Sclerothium* leaf spot, and *Alternaria* wilts.

Soilborne diseases

Aspergillus niger, Aspergillus flavus, Macrophomia phaseolina and Rhyzoctonia solani are the most common pathogens causing seed rot during sprouting. Sorting and treating seeds before sowing are the most effective and economically feasible means of controlling these diseases. If Macrophomia is identified as the causal agent infected groundnut plants must be uprooted and destroyed.

Soil pests

The most extensive field damage is caused by millipedes, termites, whitegrubs and nematodes.

Millipedes (Myriapoda) attack young seedlings and developing pods. They cause significant damage and are difficult to control. Seedling damage can be limited by incorporating an insecticide into the seed treatment.

Termites (Isoptera) *Macrotermes* sp., *Microtermes* sp. and *Odontotermes* sp. are widespread throughout Africa. They can cause extensive damage in the field especially under conditions of water stress when they attack plant by excavating through the central axis of main roots and stems. Termites equally attack developing pods, this can be recognised by holes made under the beak of the pods. Crop damage is most severe just after harvesting. Termites cause extensive scarring of the pods which makes them brittle. The pods are then perforated and the seeds eaten. This creates a gateway for Aspergillus flavus. Treating seeds before they are sown controls termites during the first month. However, for production of first level seeds, an insecticide like carbofuran (a carbamate) is recommended at a dosage of 10kg per hectare around 40 days after planting. The residual activity of this insecticide ensures control up until the harvest. This broad-spectrum insecticide also partially controls millipedes and has some effects on nematodes. At harvest, soil must be dusted with insecticide before groundnut are stacked for curing.

Whitegrubs (Coleoptera) *Schizonycha* spp. are the larvae of Small Brown Chafers. They are found in the pod development area and feed on roots, nodules and pods. Damage symptoms include yellowing and rapid wilting of the plant. These larvae attack several plant species, however, groundnut infestation is fortuitous. Constant monitoring and chemical control must be included in any on-farm IPM (Integrated Pest Management) strategy.

Nematodes *(Scutellonema cavenessi)* are found through out the Sahel. Nematodes are soil dwelling roundworms, less than 1mm long, which bore into roots and pods. Nematode presence in the roots severely decreases the number of nodules and the activity of the nitrogen-fixing bacteria. Infected plants have yellowish foliage and severely reduced production. Pod damage is first characterized by the appearance of small brown spots. These become larger and darker as the nematodes grow. This type of damage can be partially controlled using a systemic insecticide such as carbofuran. Large scale trials conducted in Senegal showed that average pod yield can be increased by 500kg/ha using dibromochloropropane (DBCP) soil treatments after the first rains, which stimulates nematode activity.

Foliar insect pests

These can be divided into 2 groups: piercing-sucking insects and defoliators (chewing insects), most of which belong to the orders Coleoptera or Lepidoptera.

The groundnut aphid (Homoptera: Aphidiae), *Aphis craccivora* Koch, is commonly called " the black groundnut aphid". The black adult is 2-3mm long. Reproduction is always parthenogenic and there are several generations per year in tropical climates. Development from nymph to adult takes 5-6 days. These piercing-sucking insects feed on nutrients produced by the plant and damage can be particularly severe during prolonged periods of drought. Aphids form numerous colonies on leaf undersurfaces and on young shoots. They can equally be detected by the fungi (sooty molds) that develop on the honeydew excreted by aphids. This species is the vector of groundnut rosette virus. Chemical control with 300g a.i./ha of dimethoate has been reported to be very effective.

Thrips (Thysanoptera) are small, slender insects 2mm long and 0.5mm wide. They can be either yellow, brown or black. The wings are fringed and the tarsi have a vesicle called an "arolium" that allows them to stick to slippery surfaces. The most common thrips that attack groundnut in Africa are Scirtothrips dorsalis, *Thrips palmi, Frankliniella schultzei* and *Heliothrips indicus.* Thrips are piercing-sucking insects. They destroy the parenchyma of the plant with their short stylets and so reduce photosynthetic capacity. Reproduction is often parthenogenic and they can produce up to 15 generations per year, especially under hot, humid climatic conditions. Apart from the use of resistant varieties, chemical treatment with 15g a.i./ha of Deltamethrine (Decis®) or with systemic products can be used to control high infestations.

Leafhoppers (Heteroptera) are tiny insects belonging to the family Cicadellidae-Jassidae. Several species of the polyphagous genus *Empoasca (E. kerri, E. fasciallis and E. lybica)* are among the most important insect pests of groundnuts in Senegal. These insects can cause direct damage by removing plant nutrients from the parenchyma and by injecting toxic enzymes that cause organ malformation. Egg oviposition into the tissues can also cause wounds with secondary effects. Most of these species are vectors of viruses or mycoplasmas. Drought stress increases damage. The main symptoms include leaf rolling near leaf bases, yellowing of leaflet tips, stunting, shortening and malformation of the internodes (dwarfism). Chemical treatment with systemic products like dimethoate (200-250g a.i./ha) provides effective control.

Caterpillars (Lepidoptera: Arctiidae), include *Amsacta moloneyi,* commonly called the "Hairy Cowpea Caterpillar" a very polyphagous insect that also attacks groundnut. The adult is 12-16mm long with a wingspan of 35-40mm. The larva is a hairy defoliating (chewing) caterpillar with a yellow head and yellowish brown-patterned segments with ochre nipples. Adults appear 3-5 days after the first substantial rains and lay their eggs on young plants. This species can go through 3 to 4 generations per year. It can be controlled by cultural practices (end of cycle ploughing, late sowing). Treatment of young larva with insecticides such as endosulfan (250g a.i./ha), monochrotophos (300g a.i./ha) or fenvalerate (100g a.i./ha) and biological control with *Bacillus thuringiensis* are also recommended.

Groundnut is attacked by various species of hairy caterpillars in other countries. These all belong to the family Arctiidae and include *Amsacta albistra, Amsacta moori* and *Diacrisia obliqua*.

Harvesting / Digging

Optimal harvesting date is one of the first problems to be solved. Flowering is indeterminate in the groundnut, there is therefore a variable proportion of mature, immature and developing pods at the end of the crop cycle. Premature harvesting of the crop leads to quantitative losses in production, impacts on oil and protein content and on seed viability. If the soil is moist, keeping non-dormant varieties in the field for longer than the average cycle duration causes high level of pre-harvest germination of mature seeds. This delay

Digger.

exposes pods to pest attack; increases seed acidity and aflatoxin contamination which have direct consequences on depreciation of seed quality. The most pertinent test for monitoring groundnut maturity is checking the internal parenchyma of the pods. It must be turgid, smooth, and dry ranging from white to dark brown. Mature pods are adequately indicated by the presence of several brown spots. Fields must be sampled from the theoretical date of pod maturity (varietal cycle) by pooling several plants and analyzing their pod maturity. The crop can be harvested once there are 70-80% of mature pods. In non-dormant varieties, the crop is considered to be mature when 2% of the plants have germinated seeds.

Digging consists of cutting the main root below the pod bearing area. Plants are then dug up and shaken in order to remove soil adhering to the pods. This operation is generally manual. The main root is cut with a sharp tool, plants are then manually dug up, shaken and placed into stacks for rapid curing. These operations take an average of 150 hours per hectare but can very easily be mechanized. A simple tool, drawn by an animal can be used. It consists of a triangular blade 20-50cm wide (depending on the type of cultivation) supported by a metallic framework with two steering arms, a front wheel and a hook for the harness. With this equipment, digging is three times faster than by hand. This basic equipment can also be used as a weeding hoe.

Computerized aids for seed production

Information management

Information can be managed in a written form, however using computerized software like spreadsheets, is also an excellent technique. Information sharing can be problematic because of technical or logistical reasons (methods used for creating data sheets). Since information management depends on the user's perspective, the data as well as the interventions that allow it to be exploited must be described in order to share the information.

Computers and computer scientists

The world of computers is well known but the seemingly cold, controlling, calculating world of computer scientists is little understood. Appearances can be misleading; computer scientists listen to problems and use their tools and methods to find solutions.

The computer scientist develops a series of simple actions that aid in solving repetitive or complex problems. In order to do this; he uses specific tools called programming languages. These require a structured environment in which to function. Such an environment is created using analytical methods for actions, or databases for information management.

Databases

The user must employ the database to create an image of the working environment. Specific questions must therefore be asked about the different components of this environment and the elements that link them.

The possibilities offered by databases are as follows:
- avoidance of redundant information (needless duplication can cause errors)
- verification of the integrity of the data
- assurance of rapid searches using multiple criteria
- possibility of database development without having to start from scratch.

A database guarantees coherent data management (logic dependence, indexing) and can be done using an application that ensures functional dependence. Tasks are organized in order to ensure that the work is well done.

Information systems

A collection of data representing the efforts of several workers, cannot be modeled using one, single application. Several functionally linked applications (an information system) must be created in order to do this. The information systems functions like a database, however, there are fewer constraints to integration of all the different components. Components need not necessarily be computerized or homogenous. However, they should be modular since this facilitates their treatment and integration into the system.

The information system of CIRAD-CA Seed and Genetic Resources Laboratory

The data management system of the genetic resources of CIRAD-CA has been computerized from the very beginning. It was conceived for better and more widespread use of the information. Two systems were deemed adequate to manage information on seeds and varieties. Plants should be characterized using the maximum number of features. The work done by this type of databank include:

- data acquisition
- data updating
- editing of figures and catalogues
- multiple criteria searches

Emphasis is placed on the improvement of everyday tasks such as reception, storage and shipment of seeds, as well as procedures for grower certification, which makes it possible to identify and trace seeds.

The origin, destination and varietal characteristics of individual seed batches can be identified using this information system. Lists of varieties that meet specific agronomic and/or technological and/or cultural criteria can be developed for germplasm collections. Information on seed availability and viability can also be readily accessed.

SISTER: an adaptable tool for breeders

SISTER is the software used for management of varietal catalogues (annex 15). It was created to manage the data of an analytical laboratory (physical and chemical) while taking into consideration that the group of data collected for a characterization could evolve over time. The program and database structure was developed to deal with these qualitative changes without compromising the validity of the programming code.

SISTER is constructed on a modular base and reads the structures it must represent in the database. This allows it to let the user modify and overwrite applications within a reasonable period of time, without necessarily having to be a computer specialist.

GESSEM: a tool for everyday use

GESSEM was created for managing information on seeds, i.e. to be able to answer the following types of questions:

- Do you have seeds of specified varieties?
- What quantities are available?

– How viable are they?
– Where have they been sent?
– Where do they come from?
– What have you sent or received in a specified year? Who did you get them from? What country do they come from?
– Etc.

It also manages the distribution of reception and dispatch invoices in order to trace seeds, thereby facilitating their identification. Updating varietal lists, correspondents and synonyms is also made easier. Stored seeds are living things. GESSEM is a tool that allows changes in germination levels to be closely monitored.

Tools to be created or adapted

The systems mentioned above are examples of functional computerized tools that allow classical management of stored seeds and of genetic resources. However, each case must be individually studied in order to find the most appropriate programs.

Discussion

As for any cultivated species, appropriate technical guidelines must be followed to ensure quality production. This is especially true for seed production. These technical guidelines must also deal with seed and field preparation as well as crop cultivation and harvesting.

All participants should note that there has been a slackening in the way that certain basic cultural practices that help to ensure good crop development, are carried out. For example an accessible, everyday practice such as seed treatment seems to be unfortunately, lost.

In the sub-region, technical recommendations have been closely followed for research produced breeder and foundation seed. Manuals, as well as government organizations that ensure that recommendations are followed, exist in several countries. Although this may be possible for small quantities of certified seeds, implementation on a larger scale would be difficult because of limited financial and human resources. For example, in Senegal where 20,000 tons of certified seeds are currently being produced, the national seed inspection service can only analyze last-generation seed batches through sampling because of lack of resources. UNIS does its own internal monitoring since they are concerned about seed quality and this is recognized by their customers. However this system must also include inspection by a more objective government agency.

In conclusion, it seems that anyone involved in the groundnut seed industry is aware of the concept of quality, the need for technical guidelines and production standards, as well as the need for setting up a system of inspection. This concept needs to be especially applied to mother seeds produced by researchers. Quality management is much more flexible for multiplication at other levels and is implemented using the following guidelines:
– certified seeds destined for large scale and commercial producers of confectionery groundnuts, produced by private farmers capable of dealing with the human and financial constraints involved in strict compliance to technical guidelines
– good quality non-certified seeds (farmers' seeds) produced following less restrictive technical guidelines and destined for small farmers
– seeds from various sources accessible to producers with small incomes

The industry is now moving towards seed production systems that are adapted to demand.

Computerized management of stocks

A presentation on computerized management of seed production was made alongside those on post-harvest technology. Participants showed great interest in the proposed computerized tools: SISTER, created for the management of germplasm resources and GESSEM, created for the management of stocks. These tools were even more appreciated since management of seed stocks is done manually, in the majority of countries.

In Mali, information is collected, filed, and then sent to the Seed Management Department for archiving (Direction des Semences). Incoming and outgoing seeds, area under cultivation, yields, production, commercial quantities etc. are indexed on these files. In Ghana a similar system is used. In Mauritania, information management is computerized (producer identification, initial stocks, outgoing stocks quality etc.) and covers basic and certified seeds produced by private companies.

In Guinea, information is prepared by each research center (quantities sold, customers etc.). This data is then sent to the national agricultural statistics service for analysis. In Niger information exchange is almost exclusively verbal, consequently large quantities of seed are informally managed. Finally, in Benin, information supplied by different seed producers (researchers, production centers, and national seed services) differs according to user expectations.

Thus, in most countries of the sub-region, a lot of research level information is available but mainly on small quantities. Management of seed resources is based on data collection. The data must not be lost or biased since these are used to generate national statistics and thereby facilitate improved planning of future production.

Although computerized seed management systems are better adapted to research centers, large private companies or seed producers, participants were invited to inform their organizations of the existence of these tools, in order to better develop and use them in the respective countries. SNRA urges funding agencies to invest in setting up these computerized management systems and therefore aid seed production in the region, keeping in mind that these tools can be used to manage several species at the same time.