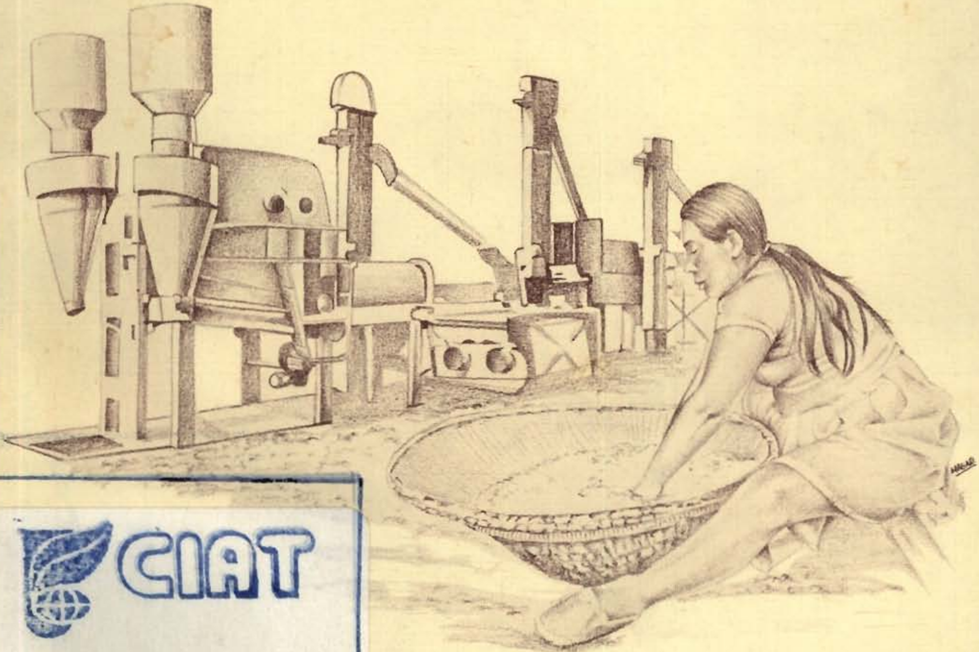
# Seed For Small Farmers

## - Support Infrastructure -



# SEED FOR SMALL FARMERS
## - SUPPORT INFRASTRUCTURE -



CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT)
Seed Unit
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# SEED FOR SMALL FARMERS
## - SUPPORT INFRASTRUCTURE -

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## I. INTRODUCTION

Plant technology research has contributed significantly to increased production and productivity of various crops. This contribution is the result of the systematic and continuous effort of all institutions involved in the agricultural sector, seeking to find the best options in both technology generation and transfer, in order to maintain the agronomic, genetic, and morphologic characteristics of the new varieties released by research.

Among the various inputs included in the technology transfer process, seed represents the basic bridge established between farmers, on one side, and the benefits generated by research, on the other. This work may mean an increase from a few kilograms of basic seed to the production of various tons of commercial seed, through a multiplication process of many generations, under special production norms different from those used in grain production for consumption. Ideally, the result of this process should be the supply of good quality seed as an input in large, medium, and small farming operations.

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However, seed supply is extremely heterogenous among large and medium agricultural entrepreneurs. In Latin America, utilization rates of improved seed (certified, fiscalized, and other) are still low, considering the requirements of agricultural development in a modern situation.

Under these circumstances, the process of transferring the genetic potential of new cultivars involves seed producers and marketing agents on the one hand, and, on the other, the large farmers and some medium-scale farmers who purchase this input. Both are agricultural entrepreneurs who make considerable investments, based on the economic profitability of their activities.

In the above situation, seed producers are involved in what is known as CONVENTIONAL SEED PRODUCTION AND MARKETING SYSTEMS, in which research, technical assistance, users of the product, and government support are well geared to guarantee stability in their endeavors. In conventional seed production and supply systems, in addition to what has been explained, the seed producer and marketing agent benefit from certification programs, fiscalization of the market, and the dynamism characteristic of the private sector.

In contrast to the situation described above, are small farmers who to a great extent do not use improved seed.* Traditionally they have either produced their own planting material or obtained it from neighboring farmers or regions through mechanisms which many times do not involve cash payments, but rather the exchange of seed for other goods or services. Small farmers have been thusly characterized by various authors who, in general terms, provide similar information. Knowledge of the variables which describe the social, economic, and cultural conditions of these farmers is available, but little has been contributed in terms of designing strategies or alternatives to improve their seed production and supply.

This paper presents the efforts carried out by the Centro Internacional de Agricultura Tropical (CIAT) with the object of contributing

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* In a broader sense, improved seed implies good quality seed (genetically identical and pure, free of weeds and diseases, and physiologically pure) of both the improved and the traditional varieties.

to the development of options for the NON-CONVENTIONAL SEED PRODUCTION AND SUPPLY SYSTEMS. To this end, a very simplified seed conditioning plant was constructed. This document will address the aspects related to the postharvest phase in this experimental plant.

## II. BACKGROUND

Implementation of non-conventional seed production and supply systems requires organizational and quality control activities, centralized in a seed conditioning plant, to meet the system's requirements for specialized technical assistance, training, internal quality control, and mechanization of certain activities. This conditioning infrastructure, unique for its type in Latin America, performs the following services:

1. It enables the study of alternative seed production, conditioning, and distribution alternatives.
2. It facilitates CIAT's Seed Unit's role in providing information and training to rural leaders, extensionists, and seed technologists.
3. It serves as a conditioning plant for small seed lots produced in the Seed Unit, under a quality control scheme.
4. It serves as a protype and a central point for radiating technologies to small farmer organizations involved or interested in seed production.

In addition to the above, this effort is unique and important since CIAT is the only center in the CGIAR System having a Seed Unit within its structure, working with crops having particularly strong social characteristics, such as beans and cassava.

## III. OBJECTIVES

1. Demonstrate the feasibility of implementing simple seed conditioning and quality control structures, at a low cost and

adapted to the needs and resources of small farmer communities, by integrating seed reception, drying, conditioning, storing, and distribution activities within this structure.

2. Provide training to extensionists, field inspectors, and leaders of small farmers' organizations in seed production and marketing activities appropriate for non-conventional seed production and supply systems.

3. Utilize the infrastructure for conditioning small, basic seed lots.

## IV. SUPPORT INFRASTRUCTURE

The Seed Unit, in addition to having a physical infrastructure for seed technology training under conventional (entrepreneurial) models is also involved in non-conventional activities. To improve and broaden this endeavor, a mini-seedhouse was constructed with special characteristics for developing alternative schemes, compatible with the specific conditions of small farmers (Figure 1).

The objective of this simple seed conditioning infrastructure goes beyond its physical structure. Once constructed, it seeks to diffuse the principles of non-conventional seed production and marketing systems, through the organization of small farmers in associations and other community groups, generating new activities and sources of income for the rural communities, especially in regions and crops unattended by large seed enterprises.

In addition to its function as a center for seed reception, drying, conditioning, storage, and distribution, when in-place in a community, this mini-seedhouse serves as the prototype for the headquarters of an association or cooperative of small seed producers. It becomes a meeting place for discussing technical and socioeconomic problems, a place for training all human resources involved in this activity (extensionists, rural leaders, producers, etc.), and also the core of quality control for seed produced under this system.

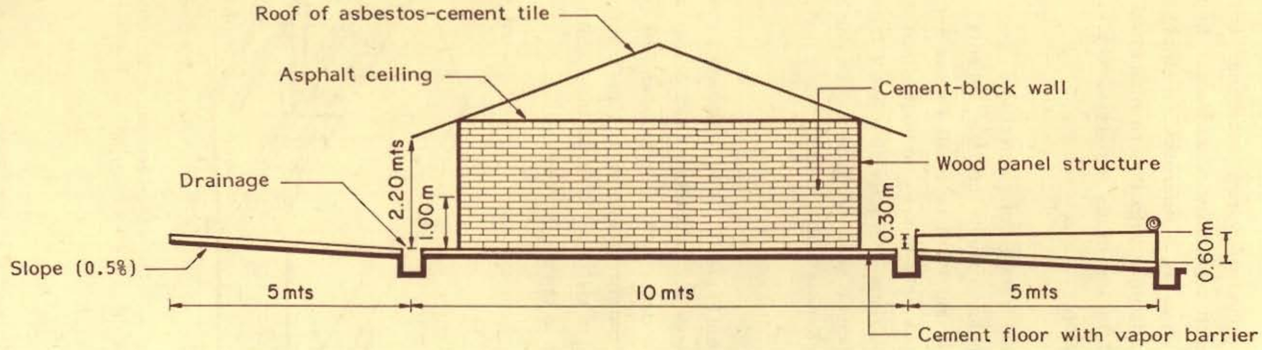



FIGURE 1. Cross Section of CIAT's Small-Scale Seed Conditioning Plant or Mini-Seedhouse.

The ideal type of construction varies according to the needs and resources available in each community of farmers. In this sense, this model only intends to serve as a reference for those who having the opportunity of becoming familiar with it, are interested in constructing their own unit, adapted to the needs and resources of their country, region, community, or crop.

Considering the broad range of objectives proposed and the heterogeneous technological level of the clients involved, this Small-Scale Seed Conditioning Plant or Small Farmer Mini-seedhouse has equipment from the very simple to more industrialized machinery. Yet, it is adapted to the conditions characterizing small farmers, seeking to transform them into efficient seed producers. Basically, CIAT's Seed Unit Mini-seedhouse is composed of:

1. Civil Works

The mini-seedhouse (Figure 2) has a 200-$m^2$ covered area, with 32$m^2$ for storage, an area for installing small-scale seed conditioning equipment, and an batch dryer with four independent cells. The mini-seedhouse also has two cement patios, each 100$m^2$, for seed threshing, precleaning, and drying activities. One of these patios is adapted so that a tarp can be used to cover up the seed.

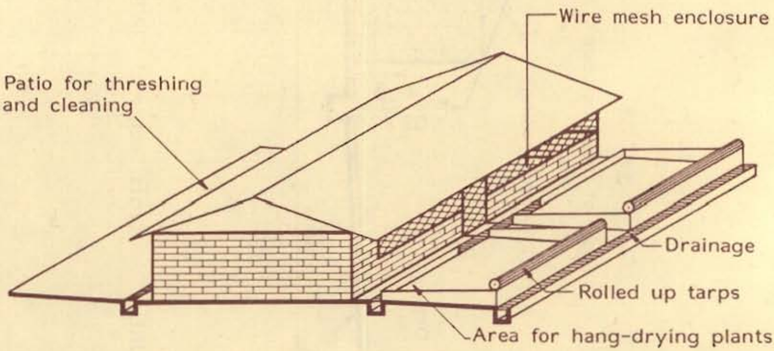



FIGURE 2. Overview of CIAT's mini-seedhouse showing tarps used to protect the seed during drying, when climatic conditions are unfavorable.

2. Basic Equipment

The equipment in this unit is organized in such a way that it can be exchanged to serve different species, volumes, and different work flows during the postharvest phase. This flexibility is important to demonstrate the diversity that can be offered to small farmers to address their specific needs. The basic equipment for seed conditioning available in this mini-seedhouse is classified in three groups, corresponding to the different technological phases that may arise in a cooperative, association, or other form of small farmers' community organization (Table 1).

## V. PRODUCTION AND SUPPLY ACTIVITIES

### A. Interdependence with Preharvest Management

The operations carried out in the Small Farmer Mini-seedhouse are related to typical postharvest activities. It is worth specifying that operations after harvesting cannot make "miracles". They do not improve the physiologic or genetic quality, or the health status of the seed, even though they can in fact improve the total seed lot composition by removing undesirable material and preserving the quality received, thus minimizing deterioration during storage.

There are a few important points to be held in mind during the preharvest phase.

1. Seed for planting must have good germination, vigor, and purity.
2. The land must be adequately prepared for planting; crop rotation should be put in practice, following technical recommendations.
3. The required cultural practices (weeding, eradication of atypical and diseased plants, timely crop protection) should be performed.
4. Harvest should be carried out as early as possible, removing the seed from the field and placing it in a fresh and ventilated area.

Appropriate preharvest management increases the efficiency of postharvest activities--reducing production costs as well as achieving expected quality standards. But, on the other hand, if preharvest management has been inadequate, it will be practically impossible to correct previous errors during the postharvest phase, leading to losses both in quality and quantity and increasing production costs.

Table 1. Theoretical distribution of various types of equipment depending on the degree of development of a seed enterprise.

| | Unit Cost (US$) | Figure No. | Phases | | |
|---|---|---|---|---|---|
| | | | Initial | Inter-mediate | Ad-vanced |
| Platform scale (500 kg) | 300 | – | | | X |
| Hang-drying in bunches | 100 | 3 | X | X | |
| Threshing rack | 50 | 4 | X | X | X |
| Motor-driven thresher | 500 | – | | | X |
| Hand shelling board | 10 | 5 | X | | |
| Crank hand sheller | 100 | 6 | X | X | |
| Motor-driven corn sheller | 250 | – | | | X |
| Backpack air blower | 300 | 10 | | | X |
| Wire mesh screen | 30 | 7 | X | X | |
| Crank blower | 120 | 8 | X | X | |
| Air blast blower | 220 | 9 | | X | X |
| Drying trays | 30 | 12 | X | X | |
| Drying patio | 180 | – | X | X | X |
| Batch dryer | 2.500 | 13 | | | X |
| Air screen cleaner | 200 | 15 | | X | X |
| Hand-sorting table | 120 | 16 | X | X | X |
| Manual treatment drum | 80 | 17 | X | X | X |
| Self-feeding hopper | 100 | 16 | X | X | |
| Scale (10 kg cap) | 190 | – | X | X | X |
| Labeled bags (5 y 10 kg) | 1 | 18 | X | X | X |
| Manual bag sewer | 400 | – | | X | X |
| Wooden platforms | 20 | 19 | X | X | X |
| Drying tarps | 200 | 11 | X | X | X |
| Moisture determinator | 120 | – | X | X | X |
| Probes | 300 | – | X | X | X |
| Laboratory scale (1 kg) | 130 | – | X | X | X |
| Germination trays | 5 | 20 | X | X | X |
| Psychrometer | 10 | 14 | X | X | X |
| Small germinator | 280 | – | | | X |

* Estimated at CIAT's Seed Unit, March 1989.

## B. Postharvest

The infrastructure previously described functions as a key element in the production process. The small-scale seed conditioning plant in fact performs the role of a central receptor or converging point for seed coming in from the fields of small farmers who belong to an agricultural association, region, or microregion.

During the field phase, each farmer or seed producer must be identified for internal quality control ends. Identification can be done using the farmer's name, or the number assigned to his field. Each farmer is registered on a card which contains all preharvest observations on one side and all postharvest observations and quality data on the other side (Annex 1). Annex 2 includes instructions for filling out this form. When the same farmer works with more than one variety or delivers more than once to the mini-seedhouse during the same campaign, new record cards should be made. Individual control, by lot and by producer, is very important.

Postharvest operations described herein are an essential part of internal quality control, and are thus indispensable for obtaining and preserving seed quality. Without this complementary internal quality control endeavor, all control efforts at the field level may be useless, the image of the organization within the rural communities may be ruined, and other socioeconomic losses may result. An organization having only a little infrastructure, such as the one discussed, can perform, among others, the following postharvest activities.

### 1. Reception and Sampling

The material received at the mini-seedhouse must be seed coming from those fields which have been approved for seed production. Material normally arrives in different conditions, for example:

a. Plants, pods, tassels, or moist cobs.
b. Plants, pods, tassels, or cobs having the appropriate moisture for threshing or shelling.
c. Threshed or shelled moist seed, not yet cleaned.
d. Precleaned, moist seed.
e. Precleaned, dry seed.
f. Clean, dry seed.

In any of these cases, the Internal Quality Control Activities Card must be filled out, the same that was codified and assigned to each producer during the preharvest phase (Annex 1.). It is worth highlighting that only those good quality seed lots should receive postharvest care and attention, while those lots having problems should be rejected and destined for human consumption or industrial use. This simple practice reduces risks and costs. Those lots having initial good quality should enter the conditioning flow. Depending on the condition in which the material is received, the steps or activities required to obtain good quality seed must be defined. This explains the need to assign a proper and distinct identity to each lot received.

One of the first tasks to be performed during reception is identification of the packages (sacks or other) of the material received, to avoid mixtures with other lots or the loss of identity in the future.

The product must be weighed during the reception phase and a representative sampling of the lot received must be made. Whenever possible, a sampling at the field level is convenient, right before harvesting. If the seed is received as plants, panicles, or cobs, samples must be taken at random and these must be manually shelled and well homogenized. When the seed is received threshed or shelled, a representative sampling must also be taken, using probes or samplers; if this equipment is not available, samples must be taken by hand. The total sum of all these samples must be approximately 2 to 6 kg, depending on the species.

The next operation is subdividing the compound sample; this is placed on a piece of cloth over a smooth surface and equal divisions are made with a ruler to obtain approximately 500 grams (working sample). Based on visual observation, serious or irreversible problems can be easily detected (for example, excessive heating of the seed, inseparable weeds or varietal mixtures, etc.) that imply rejecting the lot. Systematic sampling is necessary when the seed is in good condition, and precision is required regarding the invisible quality aspects (i.e., moisture content, germination, vigor, health, etc.).

Germination results are not immediate. Normally, due to the lack of a quick viability test, the moisture analysis is used to take a decision regarding drying. Material received wet must be dried immediately even without knowing its viability potential. Afterwards, with the result of the viability test, a decision is taken as to whether the lot deserves to continue the following conditioning phase, or if it will be destined to consumption.

In certain more developed systems, the tetrazolium test, the electric conductivity test of the exudate, or the physiologic germination test (evaluation of germination when the primary root emerges) are successfully used to quickly determine viability.

In most cases, a very effective "test" is the opinion of the person in charge of reception. This person must be familiar with his seed producers, the zones, the field, and the lot's history. Therefore, physical appearance seen through the "eye" of the person in charge of the mini-seedhouse is indispensable.

The health status of a seed lot can frequently be determined based on symptoms observed in the field. Varietal mixtures, contamination with weeds, and other characteristics of the lot must be continuously observed by a responsible person. These observations are valuable for taking decisions in the mini-seedhouse. Bearing in mind the need to assure quality, to reduce costs, and to integrate pre- and postharvest management, it is convenient that responsibility for both field and plant supervision be given to the same person. This is a very practical and inexpensive approach to programming seed production, especially during the initial phase when amounts are small.

Table 2 shows some operational alternatives and quality control tests, depending on the raw material received. The decision to follow a specific seed conditioning flow is very important in achieving the desired quality levels. Selecting the most appropriate option will be difficult and erratic if criteria based on simple evaluation tests are not adopted. Constant observation and the simple evaluations suggested enable the person in charge to monitor the flow and take preventive and corrective measures on time.

To illustrate this idea, Annex 3 shows a flowchart for seed conditioning and quality control, involving some possible variables and basic analyses.

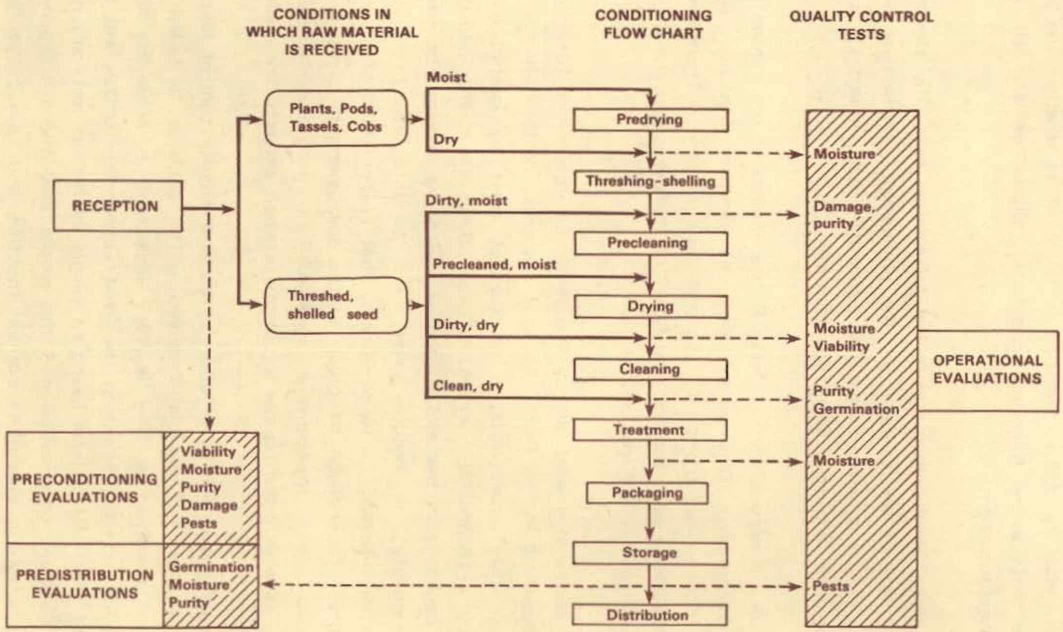



Table 2. Postharvest conditioning operations and seed quality evaluation depending on raw material received.

2. Predrying

From an economic and operational point of view, seed must be predried and threshed in the field where it is grown. This is feasible when seed is produced in dry regions where irrigation is used. It is also possible when seed matures during the dry months of the year. However, in certain areas it is impossible to avoid the rainy season and the high relative humidities by natural means in the field. This requires pulling out the plants and accelerating their drying until they are ready for threshing. This operation, when necessary can be done hanging the plants under a rooftop (Figure 3).

FIGURE 3. Predrying of bean plants under a rooftop.

3. Threshing

Normally, this is one of the operations that causes more mechanical damage to the seed, especially when moisture content is very high or very low; therefore, quick and easy moisture and mechanical damage tests must be conducted once operations have started, to determine damage and moisture levels and adjust the equipment or procedures according to needs.

Most equipment available in the market had been designed to handle grains, and not necessarily seed. Therefore, when threshing is done mechanically, it is best to use rotary cylinders, adjusting the speed of rotation of the shaft and the cavity opening; the moisture content of the seed to be threshed must also be known. Some options for equipment and methods used are shown in Figures 4, 5, and 6.

FIGURE 4. Threshing rack. This system, used throughout Central America, facilitates threshing and causes minimum mechanical damage to seeds. Seeds loosened from the pods fall through a mesh floor and thus do not receive continuous impacts. Threshing, frequently carried out by hitting the pile of harvested plants with a stick is also adequate, as long as there is enough plant matter to serve as a "cushion".

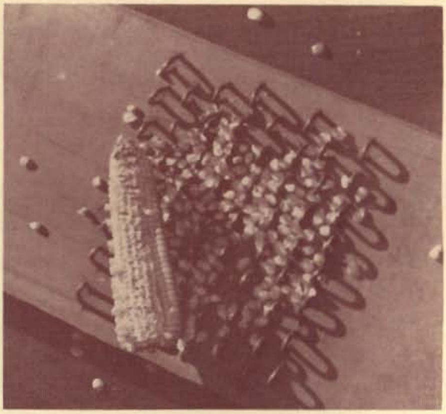


FIGURE 5. Hand shelling board. This equipment can be easily constructed using a solid table where metallic staples or bent nails are adjusted. The capacity depends only on the number of persons that will be working at the same time.

FIGURE 6. Crank hand sheller. Simple to construct and clean; used for shelling maize.

4. Precleaning

As with the threshing operation, precleaning can also be carried out in the field, using simple metal sieves and/or the backpack air blower. Precleaning is required particularly if final drying is going to be done with forced air in artificial dryers. Additionally, precleaning prevents carrying unnecessary chaff to the plant. The following pictures show some useful equipment used to carry out this task (Figures 7, 8, 9, and 10).

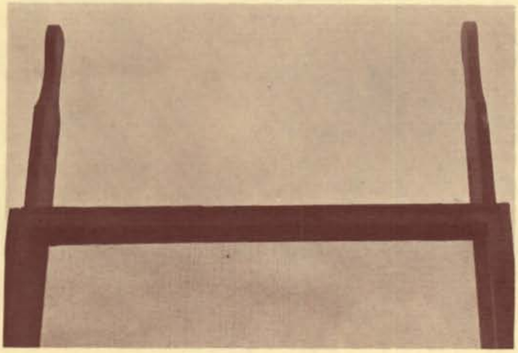


FIGURE 7. Wire mesh screen. Can be used as a scalper (to separate contaminants having a greater volume than that of the seed) or as a classifier (to separate contaminants smaller than the seed). The screen also serves to dry seed lots, by keeping them raised from the ground and permitting the flow of air.

FIGURE 8. Crank blower. Simple machine, easily constructed from wood, very useful for precleaning seed. Can be adapted to be activated by a motor to facilitate operation and increase efficiency.

FIGURE 9. Air blast blower (normally used in laboratory for research experiments). Similar to that shown in Figure 8, but motor-driven and constructed from metal. Very appropriate for small amounts of seed. It can be easily adapted to have a constant flow of air.

FIGURE 10. Backpack air blower, normally used to apply chemical products in the field. Useful in separating light components (stems, dust, leaves, pods, etc.) after threshing.

5. Grain Drying

This step is critical in the process of obtaining and preserving seed quality. The drying process must be performed as soon as possible after threshing, particularly in seed lots having high moisture content (greater than 15%) in order to guarantee safe storage. In a small plant, this operation can be carried out using natural or artificial drying systems. Each system includes various alternatives, as can be observed in Figures 11, 12, and 13.

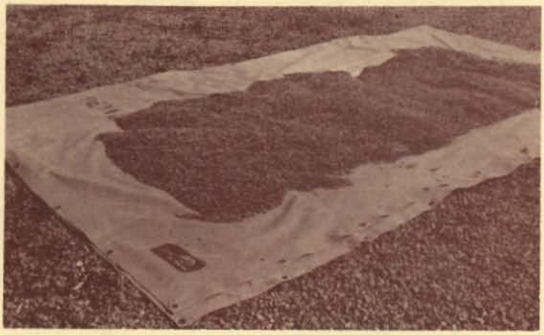


FIGURE 11. Drying tarps. Important in threshing and drying, and in pesticide applications. Must be fabricated of a resistant and water impermeable material to keep out the moisture always found under field conditions.

FIGURE 12. Drying wire mesh trays. The openings must be smaller than the seed. These trays should be raised from the floor to allow air to flow easily and accelerate drying.

FIGURE 13. Batch dryer. Constructed in brick and cement, this dryer allows seeds to be dried independently in each of the four cells. The inclination of the floor facilitates unloading dry seed.

During drying, continuous care is required to avoid accidental damage. Seed should be removed frequently in natural drying. During the operation of any drying system, in addition to initial samplings, samples must be taken during the intermediate phases in order to decide on preventive or corrective measures when these are necessary. This guarantees efficient and sure drying.

When seed moisture is above 18% and relative humidity is below 75%, the air should not be heated. When relative humidity is over 75%, air should be heated to reduce relative humidity to 75%. When seed has less than 18% moisture content, air must have a relative humidity between 50 and 60%. In case this is greater, air must be heated without exceeding the 40°C limit. A simple piece of equipment to measure these environmental and seed parameters is the psychrometer (Figure 14).

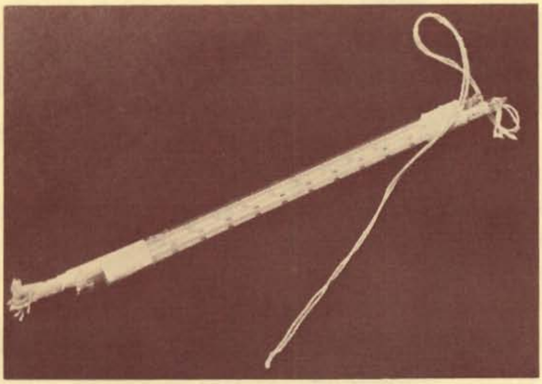


FIGURE 14. Psychrometer. Simple instrument used to determine air temperature and relative humidity. These factors are very important in decisions related to seed moisture content.

6. Cleaning

During this phase, "seed separation principles", broadly used in conventional conditioning systems (differences in thickness, width, length, weight, form, texture, etc.) are equally useful in non-conventional cases. The major difference is that in the latter case, the machinery and equipment can be small, simple, and inexpensive (Figure 15).

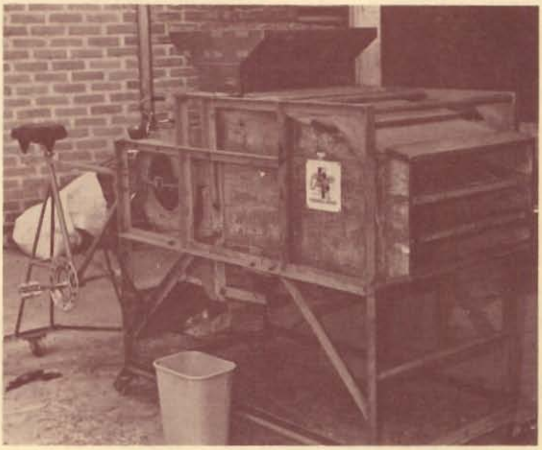


FIGURE 15. Air screen cleaner. Can be activated by pedal or by electric or gasoline engine.

Adequate use of the separation principles, the samplings, and the qualitative analyses at strategic points of the conditioning flow can significantly improve seed lot quality in a production system (Annex 3).

In non-conventional seed production systems, primarily when dealing with small-scale production, precision classification can be performed through manual selection (Figure 16).

FIGURE 16. Hand-sorting table (showing self-feeding hopper). The slope of hopper's walls make it self-cleaning and supply a continuous flow of seeds to the person making the selection.

This practice is rather simple when dealing with seeds the size of beans or maize. Once the cleaning and classification tasks are over, a sample should be taken to analyze purity and germination of the final product.

7. Treatment

After completing the cleaning and classification operations, seed can be treated with agrochemical products if considered necessary. In the case of fungicides, seed should preferably be treated only when sales have been assured; otherwise, if not sold as seed, treatment prohibits human consumption. Simple equipment, having different capacities (Figure 17), can be manufactured at the plant itself for this operation.

FIGURE 17. Manual treatment drum. The container can be either plastic or metallic. Inclination facilitates unloading of materials.

Even when the demand for seed is unknown, treatment against insects must be applied. Insecticides and products that do not have noxious residual effects for human consumption should be used. Final treatment with chemical fungicides must be done gradually as per purchase requests.

Normally, chemical products are harmful to human health; therefore, all precautions should be observed and followed in accordance with the technical recommendations indicated by the manufacturer.

8. Packaging/Identification

Seed that has been properly conditioned and treated should preferably be packaged in multifoliate bags, sewn shut, and individually identified. Packaging equipment is available that provides a barrier against water vapor pressure and insect attack. Common packages, predominant among small farmers, are jute, polypropylene, or cotton sacks; 10-20 liter jars; and plastic containers (Figure 18).


FIGURE 18. Labeled bags. To package 5 and 10 kg of seed. Convenient in marketing small amounts of seed.

When seed has been packaged for sale/distribution, packages must be identified on the outside with the required information, by stamping directly on the container or by adhering a label having at least the data presented in Annex 4.

This data can be taken from the card explained in Annex 1, and is very necessary as a source of information for farmers purchasing the seed.

9. Storage

Good storage does not improve the seed's physical, physiologic, or genetic quality, or its health status; it can only reduce the speed of deterioration. Even so, quality loss is inevitable in practical terms. Seed that has been properly dried, conditioned, and identified should be stored in a clean, fresh, ventilated warehouse, isolated from sources of humidity. Piles should be placed over wooden platforms as shown in Figure 19.


FIGURE 19. Wooden platforms. Essential in storing seeds. They prevent moisture from passing into the lower layer of seeds, help aeration and fumigation of the stack, and facilitate cleaning between stacks.

Each pile must be identified with a tag in order to have visible and practical information available in the warehouse, for taking decisions during commercialization. The tag should be placed in the pile and have the required information. A sample tag is shown in Annex 5.

The possibility of having one variety per pile should be considered; this facilitates delivery and inventory management.

10. <u>Basic Tests</u>

Normally, when considering carrying out tests in conventional seed production and supply systems, worries arise in terms of the high cost of laboratory equipment, infrastructure, human resources, etc.

These considerations are valid since the system requires these investments due to its profit-earning characteristics, to the rigorous norms and standards, and to the need that test results be precise and replicable. Tests in these cases are conducted under ideal conditions (controlled moisture and temperature) in modern germinators.

Equipment for the purity, moisture, germination, tetrazolium, and health tests, among others, are also modern and relatively expensive.

Under less conventional seed production and supply situations, these conditions are normally not available; small seed farmers do not have the human, physical, or financial resources to support a sophisticated assembly of equipment to attend their needs. However, certain key qualitative seed characteristics can be evaluated based on simple schemes.

The basic tests described here are based on traditional principles, yet they require in many cases only the resources and materials available in a community of organized farmers. These tests are:

a. Germination test

Contrary to other tests which can be evaluated immediately, evaluation of the germination potential requires more time. However, depending on the objective of the evaluation, a series of options can be considered--from complete germination tests to more simple and quick estimations.

To determine real germination, sand trays, rolls of special paper, or disposable paper towels or newspaper can be used. Instead of sand, a mixture of soil and organic matter, or soil alone, is appropriate. The latter would result in more variation than the sand test, but would also enable the evaluation of the seed under conditions similar to those encountered in the field by the farmer.

In addition to the information on germination, evaluations in trays provide a very practical appreciation of seed vigor. Representative samples of the lots are required to obtain reliable results and 300 to 400 seeds must be planted. Depending on the size of the paper, the trays, etc., groups of 100 or 50 seeds can be planted. Figure 20 shows a sample of this test.

In the absence of special chambers, in tropical regions, germination tests can be made taking advantage of the ambient temperature. In this case, depending on the ambient temperature, germination percentage can be evaluated in the time period stipulated in Table 3.

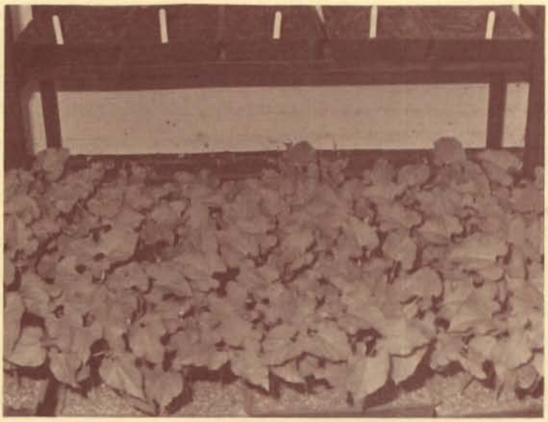


FIGURE 20. Germination trays. Used to carry out the sand germination test.

Table 3. Appropriate time for conducting the trials.

| Species | Days After Planting | |
|---|---|---|
| | First Count | Final Count* |
| Beans | 4 | 8 |
| Maize | 4 | 7 |
| Rice | 5 | 14 |
| Sorghum | 4 | 10 |
| Soybeans | 5 | 8 |
| Wheat | 4 | 7 |

* In regions where the temperature is cooler, the germination and seedling development processes are slower. This can be easily compensated by evaluating 1-2 days after the dates indicated in the table.

When time is urgent, germination percentage can be estimated based on the tetrazolium or conductivity tests or using other methods. A method available to many farmers is the evaluation of physiologic germination. This method enables evaluation of the basic seed structures as soon as the primary roots have emerged. Depending on the species and the temperature, this evaluation can be done 2 or 3 days after planting.

b. Determining moisture content

Moisture is the main factor causing seed deterioration. Seeds with moisture contents above 14% have a shorter life than those with less than 13%. Thus, especially when receiving lots and during the drying process, determination of seed moisture content is necessary to enable taking decisions and to guarantee the appropriate moisture level after drying for subsequent storage.

Determining the moisture content under non-conventional conditions has been one of the most difficult tasks in the rural communities. Designing a simple method, available to the small farmer, for determining seed moisture is currently the most important challenge in seed technology. In the meantime, portable electronic testers constitute a viable alternative for these production schemes. In spite of not having the precision of the oven method, these testers are easy to operate, inexpensive, and provide an immediate reading.

c. Determining physical purity

This test identifies the type of contaminant, and therefore the type of equipment through which the seed lot must flow to separate inert matter, weeds, and diseased seed or seed of other varieties that may be mixed with the desired variety.

This trial must be carried out upon receiving the lot and at the end of the conditioning process. The first, because of the reasons already mentioned, and the latter, to guarantee that the seed lot does not contain weeds or diseased seed. Furthermore, this test is important before and after precleaning and cleaning operations because it defines the rigor of the required separations.

When possible, the final purity test must be sent to a laboratory accredited to carry out this analysis. This is the result to be used in the labels or packages for marketing the seed.

d. Detecting mechanical damage

Seeds with mechanical damage lose their viability quickly in the warehouse, giving rise to weak and abnormal seedlings. Therefore, care must be taken to not cause damage to the seed during the threshing and postharvest phase. Mechanical threshers, shellers, elevators, etc. can be sources of mechanical damage to seeds. Frequent samplings and tests to evaluate mechanical damage are required during these operations, in order to make adjustments to the machinery and equipment.

For example, a bean seed lot must not have more than 8% visible damage. A simple test to determine the degree of damage to a lot is the utilization of a glass of water in which 100 seeds selected at random are placed. This test can be replicated 2-4 times to have greater confidence in results. Seeds are allowed to stand in water during 10-15 minutes. After this time, seed is removed from the glass and those having visible mechanical damage are counted in each repetition, thus determining the average percentage damage of the seed lot.

Upon delivery, other damage caused to the seed by various factors, among others, diseases, moisture, insects, rodents, etc., must be determined.

e. Detecting pests: During reception and storage, seed must be carefully inspected in order to detect pest infestation and proceed with the required control.

When the evaluation methodologies described above are correctly used, internal quality control can be established under the local conditions. As the volume of seeds and the clients' demands, and as the personnel acquires more experience, other more complex tests can be used; among these are the tetrazolium test, the phytosanitary analyses, the vigor test, the varietal identification test, etc.

## VI. COMPLEMENTARY ACTIVITIES

### A. Training

CIAT's Small Scale Seed Conditioning Plant or Mini-seedhouse has facilitated a considerable amount of training activities related to non-conventional seed systems at the international level, given the simple characteristics of its organization and equipment. This equipment has enabled the Seed Unit to establish a series of research and teaching activities in a very efficient manner, focusing on the characteristics of agriculture in the great majority of underdeveloped countries.

In addition to the proper physical installations, the presence of a multidisciplinary team in CIAT's research programs makes it possible to cover practically all technical and scientific aspects directly or indirectly related to seed technology.

## B. Research

The bibliography on research in seed technology for conventional seed production and supply systems is very broad. But, it is difficult to find research papers on alternative seed production and supply systems under non-conventional schemes adapted for small farmers' conditions.

In 1988, CIAT's Seed Unit started a series of studies to complement research carried out by the Cassava, Beans, Rice, and Tropical Pastures Research Programs, seeking to find technological and practical alternatives to maximize the use of the genetic potential available in materials used by small farmers. Among these studies, the following are directly related to the type of work that can be carried out in a mini-seedhouse as has been described.

- Effect of Harvesting Period on Bean Seed Quality
  Objective: Identify damage caused by the delay in harvesting on the physiological quality and health status of bean seed.

- Effect of Chemical Treatment and Cultural Management on the Quality of Bean Seed
  Objective: Contribute to the design and evaluation of simple technological recommendations for good quality bean seed produced by small farmers.

- Effect of Cultural Practices on the Quality of Bean Seed
  Objective: Investigate the possibility of improving the quality of planting materials used by small farmers by detecting and eradicating visible sources of contamination by diseases in the field and borne by the seed itself, seeking to increase the productivity of small producers.

- Effect of the Drying Method on the Quality of Rice Seed
  Objective: Study the influence of the drying method on the process of fissure formation in rice seed and on the physical and physiologic quality.

- Evaluation of the Quality of Bean Seed Used by Small Farmers in Two Regions of Colombia
  Objective: Come to know the quality of bean seed used by small farmers through laboratory tests to evaluate genetic, physical, physiologic, and sanitary seed quality.

Currently, in addition to the aspects directly related to seed technology, research is being carried out in socioeconomic and cultural aspects.

## VII. BENEFITS

The small-scale seed conditioning plant will bring a series of benefits to farmers in Latin America, particularly in those situations where markets are small, localized, and specific. This is the case for most non-industrial crops in Latin America.

CIAT's international status and its collaborative activities with national research and development institutions enable CIAT to contribute not only in the development of conventional seed systems, but also to provide simplified and less conventional schemes such as that presented in this paper. Directly, or indirectly, the activities in this initiative will bring the following social and economic benefits:

- Motivate seed production in communities and among agricultural organizations having an associative nature.

- Make seed production a new income-earning alternative for the small farmer.

- Increase productivity of rural communities.

- Motivate the farmer to keep up with his agricultural activities, reducing the rural exodus.

- Contribute to the small farmer's economic welfare and, as a consequence, to an increase in the production of basic food products.

Annex 1. Record of activities of internal quality control ( Name of Institution )

A. PREHARVEST PHASE

1. Date of visit __/__/__/ Technical Visit No. ____________

2. Producer ____________ Field No. ____________

3. Farm ____________ Location ____________

4. Specie ____________ Variety ____________

5. Area ($m^2$) ____________ Species/Previous variety ____________

6. Planting date ____________ Estimated harvesting date ____________

7. Development status of the crop ____________

8. Observations during field inspection:

| Sampling | No. of Plants per Meter | No. of Atypical Plants | Weeds 1/ | No. of Diseased Plants | Insect Attack 1/ | Final Recommendation | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | A | R | RI |
| A<br>B<br>C<br>D | | | | | | | | |
| X | | | | | | | | |

1/ L = Free; M = Medium; S = Severe. Specify which.

9. Chemical products applied ____________

10. Diseases ____________

11. Weeds ____________

12. Insects ____________

13. Estimated harvesting date __/__/__/ Next visit __/__/__/

14. Area harvested ____________ ($m^2$) Amount ____________ (kg)

15. Recommendations to the producer ____________

____________

____________

____________ SIGNATURE OF TECHNICIAN

____________ SIGNATURE OF PRODUCER

B. POSTHARVEST PHASE

Species ______________________ Variety/Line ______________________

Production site ______________________ Area ($m^2$) ______________________

Reception

1. Date/hour of Reception __/__/__/ ___ 2. Initial weight (kg) ______ Lot No.______

3. Date of harvest __/__/__/ 4. Type of raw material ______________

5. Initial quality: Germination ___(%) Purity ___(%) Moisture ___(%) Other _______

6. Systems used for transportation to seedhouse ______________________

7. Natural drying: YES /__/ NO /__/ Health status ______________________

8. Destination at the plant: Drying /__/ Conditioning /__/ Grain for consumption /__/

Drying

9. System used ______________________________________________

10. Starting (date/hr) __/__/__/ ___ 11. Ending (date/hr) __/__/__/ ____

12. Temperature: Initial ___°C Intermediate ___°C Final ___°C

13. Final weight _____(kg) Final moisture content _____(%)

14. Quality ______________________________________________

Conditioning

15. Threshing system: ___________ 16. Initial weight: ___(kg) 17. Moisture ____(%)

18. Mechanical damage: ______(%) 19. Rejects ___ (kg) 20. Quality ______________

21. Equipment used: Manual ______________________________ Weight ____(kg)

Mechanical ______________________________ Weight ____(kg)

22. Final quality: Germination ___(%) Purity ___(%) Vigor ___(%) Moisture ___(%)

23. Treatment ______________________________________________

Packaging/Identification of Conditioned Seed

24. Type of package ______________________ 25. Net weight _________ (kg)

26. Total weight of lot ________(kg) No. of bags ____ 27. Analysis report (no.) ______

28. Quality: Germination ___(%) Purity ___(%) Other ______________________

29. Stack No. ___________ 30. Distribution ______________________

31. Final Quality: Germination ____(%)

______________________________________

PERSON RESPONSIBLE FOR INTERNAL QUALITY CONTROL

Annex 2. Instructions for filling out the Internal Quality Control Record (Annex 1 - Postharvest Phase).

| No. | Instructions |
|---|---|
| **Reception** | |
| 1 | Date and hour when material was received. |
| 2 | Initial weight of threshed seed (without package) before drying. |
| 3 | Provided by farmer delivering the product. |
| 4 | In cobs, threshed, in plant, precleaned, or pods. |
| 5 | Percentage germination, percentage purity, and other. |
| 6 | Truck, animal, or other transportation means. |
| 7 | Check one of the alternatives offered. |
| 8 | Check one of the alternatives offered. |
| **Drying** | |
| 9 | Natural, artificial. |
| 10 | Date and hour. |
| 11 | Date and hour. |
| 12 | Fill in with temperatures used in °C: Initial (I), Intermediate (IN), and Final (F). |
| 13 | Represents the weight in kilograms and moisture in percentage, after drying. |
| 14 | Fill in with germination, purity, and mechanical damage data, and other, if considered necessary. |

(continues)

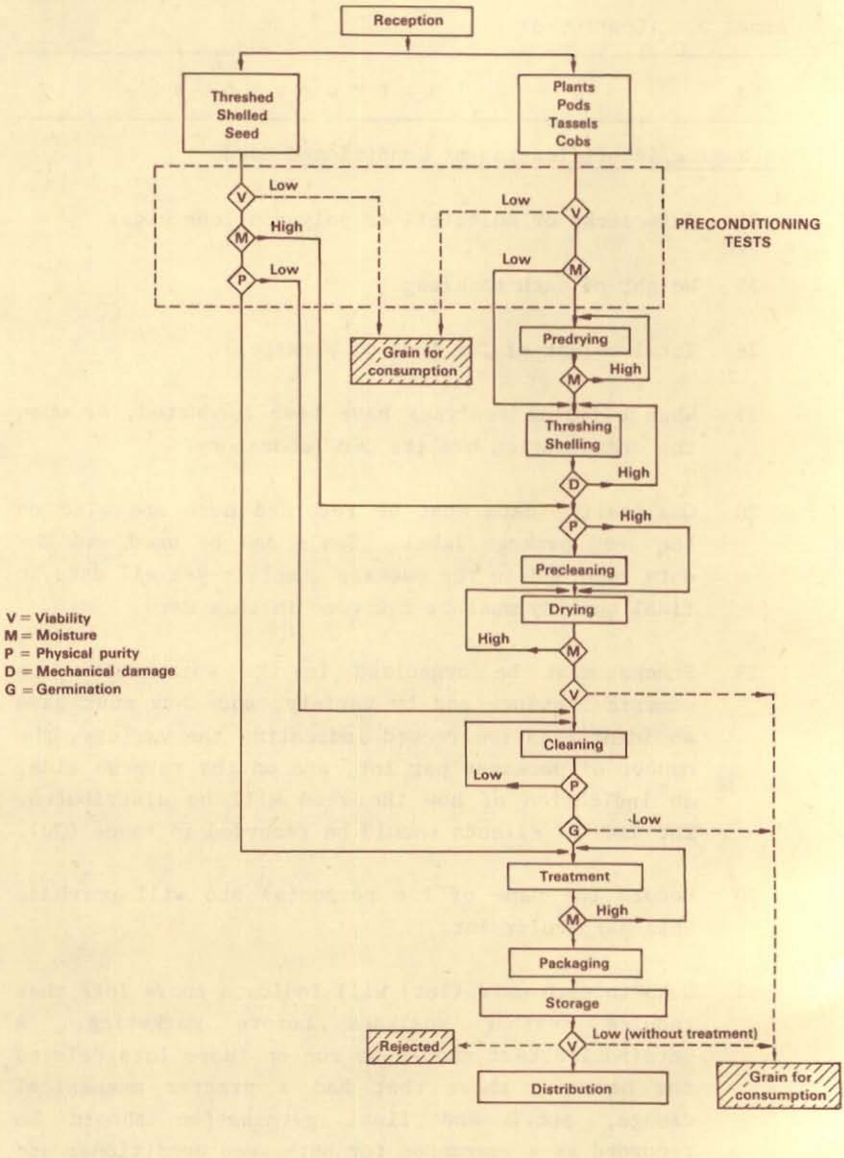
Annex 2. (Continued)

| No. | Instructions |
|---|---|
| **Conditioning** | |
| 15 | Identify threshing system: hitting piles, mechanical, etc. |
| 16 | Weight before initiating precleaning or classification. |
| 17 | Percentage seed moisture content. May be the same as that in space (13). |
| 18 | Fill in with percentage damage. |
| 19 | Optional: Can be calculated subtracting the seed's weight after threshing from the initial weight (space 16). |
| 20 | Optional: Germination tests, and, if possible, tetrazolium tests are conducted when mechanical damage is high (greater than 5%), to verify its immediate effect on the seed's physiologic quality. |
| 21 | Describe the manual types: sieves, etc., or mechanical: machines, etc. In each case all seed fractions must be weighed and recorded in the space provided. |
| 22 | Final quality: Record results of germination, purity, and vigor tests, or other conducted to analyze the pure seed fraction. |
| 23 | Specify the chemical product used in case the seed has been treated. |

(continues)

Annex 2. (Continued)

| No. | Instructions |
|---|---|
| Packaging/Identification of Conditioned Seed | |
| 24 | Jute sacks or multifoil or polypropylene bags. |
| 25 | Weight of each sack/bag. |
| 26 | Total weight of lot (set of packages). |
| 27 | When official analyses have been conducted, or when the organization has its own laboratory. |
| 28 | Qualitative data must be recorded here and also on the seed package label. Seals can be used and the data recorded in the package itself; yet all data on final quality must be recorded in this card. |
| 29 | Stacks must be organized in the warehouse in a numeric sequence and by variety, and they must have an identification record indicating the variety, the number of packages per lot, and on the reverse side, an indication of how the seed will be distributed. The name of clients should be recorded in space (30). |
| 30 | Record the name of the person(s) who will purchase this particular lot. |
| 31 | Data in each card (lot) will indicate those lots that require further analyses before marketing. A germination test should be run on those lots delayed for harvest, those that had a greater mechanical damage, etc., and final germination should be recorded as a guarantee for both seed conditioner and client. |




Annex 3. Basic flow in the conditioning and internal quality control processes.

Annex 4. Seed quality control tag to be used to label packages.

| COMPANY NAME | |
|---|---|
| Species | % |
| Variety | % |
| Lot No. | % |
| Germination (min.) | % |
| Physical purity (min.) | % |
| Seed of other crops (max.) | % |
| Seed of weeds (max.) | % |
| Net weight | kgs |
| Treated with | |


(Do not use for human or animal consumption, nor for extracting oil.)

Annex 5. Hypothetical example of individual control of a stack in the warehouse

| Side 1. Identification<br>Species/Variety: Beans (PVA 916) | | | Side 2. Distribution<br>Species/Variety: Beans (PVA 916) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Number of Bags | | | | | |
| Lot No. | No. of Bags | Producer | Movement | Lot No.3 | Date | Lot No.1 | Date | Lot No.6 | Date |
| 3 | 320 | José, L.J. | Entrance | 320 | 03/10 | 100 | 03/10 | 620 | 03/10 |
| 1 | 100 | Armando, Z. | Departure | Inv.* 20 | 03/11 | Inv. 100 | 04/11 | Inv. 300 | 04/11 |
| 6 | 620 | Vicente, O. | Remnant | 300 | - | 0 | 04/11 | 320 | - |
| 8 | 620 | Vicente, O. | Departure | Inv. 20 | 03/11 | - | - | Inv. 80 | 04/11 |
| 6 | 620 | Vicente, O. | Remnant | - | - | - | - | 240 | - |
| 4 | 620 | Vicente, O. | Departure | - | - | - | - | Inv. 200 | 05/11 |
| | | | Remnant | - | - | - | - | 40 | - |

* Invoice number or name of client.

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