N2Africa is a large-scale, research and development project focused on putting nitrogen fixation to work for smallholder farmers growing legume crops in Africa. N2Africa Phase II is implemented in Zimbabwe, Malawi, Mozambique, Kenya, Rwanda, DR Congo, Nigeria, Ghana, Uganda, Tanzania and Ethiopia.

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Putting Nitrogen Fixation to Work for Smallholder Farmers in Africa

N2Africa

Post-Harvest Handling Guidelines for Legumes

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POST-HARVEST HANDLING: INTRODUCTION

Definition of postharvest handling: Post-harvest handling is the stage of crop production immediately following harvest. It involves stages such as drying, shelling, cleaning, sorting and packing. Post-harvest technology involves all treatments or processes that occur from time of harvesting until the foodstuff reaches the final consumer.

Why do we harvest crops at the correct physiological maturity?

- To respond and complement physiological maturity stage in the crop production cycle
- To ensure food security at home through facilitating storage and processing
- To recycle nutrients through the soil
- To maintain quality and quantity of the produce
- To exploit economic benefits of produce in various forms
- To supply both humans and animals with food

The importance of post harvest handling:

- To preserve final quality of our produce
- To avoid moisture loss
- To slow down undesirable chemical changes
- To avoid physical damage such as bruising
- To delay spoilage

Post harvest handling problems with legumes:

- Pod shattering
- Labour intensive selective hand picking
- Damage by rodents or birds

Post-harvest losses may occur in the following areas:

- At physiological maturity (caused by weevils and termites, rodents, domestic and wild animals, birds, rainfall or micro – organisms)
- During harvesting (scattering and mechanical damage due to poor handling and excessive drying)
- During transportation (spillage, scattering and mechanical damage)
- During drying (rodents, domestic animals, microbes, spillage, overheating)
- During threshing (spillage, incomplete threshing/shelling and mechanical damage)
- During processing (spillage, mechanical damage)
- During storage (insects, rodents, micro-organisms or respiration)
- Processing (spillage, nutritional loss or overheating)

Losses may be in form of:

1. Quantity: Split seed, running out of damaged bags, theft, damage by pests
2. Weight: Changes in moisture content of stored grain
3. Quality: Changes in colour
   Changes in smell
   Changes in taste
   Changes in nutritional value (degradation of protein)
   Losses in cooking and baking quality
   Contamination (mycotoxins and aflatoxins)

Table 1: Major sources of losses and their causes

Source of loss	Causes
Mechanical Damage	- Incorrect harvesting methods - Poor handling, shelling/threshing, cleaning, sorting, drying - Bad transport and loading practices
Heat	- Unsuitable storage structures (insufficient shade, and ventilation facilities, lack of heat insulation) - Mass reproduction of storage pests and fungi - Lack of aeration
Moisture	- Insufficient drying before storage high relative humidity - Constructional faults and damage to store - Imbalances in temperature
Insect Pests	- Introduction of infested lots - Cross infestation from neighbouring lots or stores - Migration from wastes/rubbish - Hiding places (crevices and fissures) - Use of infested bags
Microbes	- High moisture content - High relative humidity - Condensation
Rodents	- Lack of barriers to storage - Penetration through badly closing doors, windows ventilation openings and holes
Birds	- Openings like windows, ventilation openings and roof openings

POST-HARVEST HANDLING OF GROUNDNUTS

What makes good quality groundnuts?

Purity level: This refers to the absence of foreign materials in grain such as stones, rotten grains, broken or discoloured grains. Most buyers prefer groundnuts with 95% level of purity.

Moisture content: The level of moisture in the grains as measured by a moisture meter. The best quality groundnuts should have a moisture content of 7-8%. Groundnuts with moisture content either above or below the given range are considered to be of poor quality.

Shelling percentage: This means that when shelling, at least 65% of the weight should be grain weight while the other 25% is trash. A lower percentage shows poor quality groundnuts with high deficiencies of calcium during pegging stage.

Damage: The damage refers to the proportion of groundnuts that are mechanically or physically damaged (cracked, broken) during the post harvest handling process.

Aflatoxin: These are poisonous substances produced by fungi and make the grain unfit for consumption. Good quality groundnuts should be Aflatoxin free.

Table 2: Groundnuts standards

Purity level	95%
Moisture content	7-8%
Shelling percentage	Above 65
Damage	Below 17%
Aflatoxin	No Aflatoxin

Timely harvesting is key for maintaining good quality harvest.

Challenges of *early* harvesting	**Challenges of *late* harvesting**
- Drop in oil content - Aflatoxin contamination	- Difficult to uproot as pods remain in the soil due to weak pegs
- Not saleable, low income	- Yield loss
- Shrinkage of seeds - Weight loss	- Sprouting of less dominant varieties
- Poor quality seeds	- Low income

Stages in Post-Harvest Handling of Groundnuts

1. Cleaning

- Shake off all soil from pods to discourage fungal growth
- Removal of soil from pods shortens length of drying period

2. Drying

2.1 Wilting: Plants should be inverted in windrows to allow them to wilt before curing. Seed moisture content at lifting usually exceeds 35% and this period of wilting is necessary to allow rapid initial moisture loss from pods and vegetative plant parts. Pods lying in contact with the soil are exposed to high temperatures; during wet weather, they may remain wet for long periods. In inverted windrows, air circulates around the pods, allowing them to dry rapidly after rain showers.

Under ideal conditions safe moisture levels are reached in 5-7 days. During hot weather the period is less. If weather is not very hot keep

the groundnuts in windrows for 10 days. In cool weather keep them longer. The cock is used for wilting.

2.2 Curing: After 2-3 days of wilting it is safe to begin natural curing, provided the following factors are taken into account:

- Shade: exposure to direct sunlight results in deterioration in quality. Plants should be stacked with pods innermost and foliage outermost.
- Ventilation: adequate air circulation is important to allow steady moisture loss.
- Drainage: ensure good drainage to avoid windrows and cocks being spoiled by standing in water during wet weather.

The A-frame is used for curing the crop after wilting.

The A-frame: When using an A-frame, the wilted plants are placed on the A-Frame with the pods facing down. The lowest shelf should be 30 cm above the ground. Normally, the groundnuts are left for 3-4 weeks to dry.

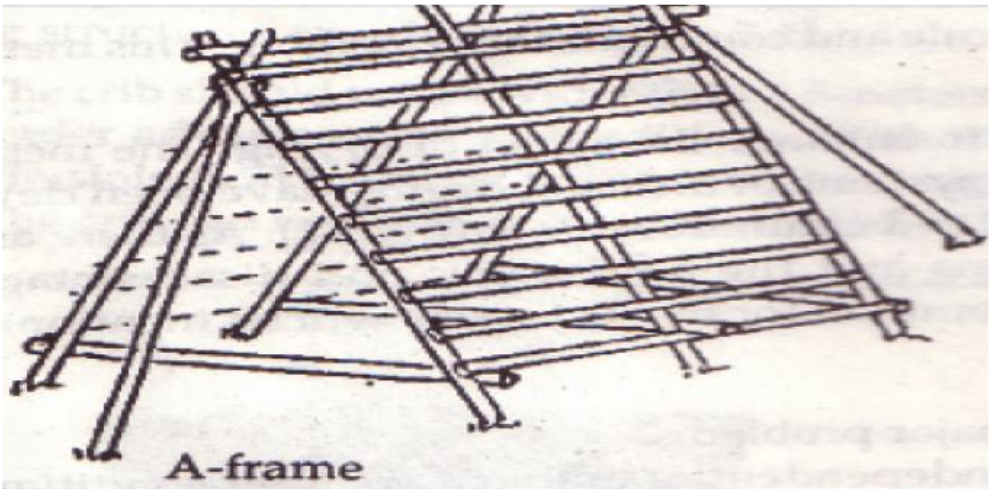

Figure 1: A Frame for drying groundnuts before picking them

It is not advisable to further dry the pods after picking as this will lead to further moisture loss and reduction in seed quality.

3. Stripping/Plucking

- It is the process of removing the pods from the plants
- This can be done manually or with the aid of a stripper

4. Storage

- Storage of groundnuts is best done in the pods since shelled groundnuts shell much faster
- Store the groundnuts when the moisture content is between 7-8%
- Remove broken, damaged, poor and fungal infected groundnuts before storage
- Store in a well-ventilated and cool place
- Do not store in plastic bags (polythene bags) as they do not allow air circulation and promote fungal infection
- Apply Actellic super on unshelled pods before storage

5. Shelling

- Groundnuts shelling should be done only when the seeds are needed for consumption, seed or marketing
- During the shelling process, discoloured groundnuts should be removed.

Table 3: Nutritional value of groundnuts

Nutrient	Percentage (%)
Proteins	25 %
Carbohydrates	12 %
Fats/Oil	48 %
Dietary Fiber	9 %
Water	4.26 %
Others (Thiamine, Niacin)	1.74 %

Aflatoxin Management in Groundnuts

- Aflatoxins are poisonous substances produced by fungi
- Aflatoxins affect quality of produce especially for groundnuts

Factors promoting contamination by Aflatoxin

Pre-harvest:

- End of season moisture stress to crop for a period of more than twenty days
- Damage of pod for instance growth cracks
- Damage to pod by insects or pod borers
- Rotting of stem, root and pods
- Damage to pod by Nematodes

Post-harvest:

- Harvesting when the crop is over mature
- Stacking the produce when moisture levels are high
- Insect damage during storage
- Storing Haulms with immature pods
- Pod rotting due to roof leakage or high moisture levels

Effects of Aflatoxins

- Fungal growth causes deterioration of pod quality
- Cancer/Hepatitis/Liver cancer in consumers
- Reduction in prices for produce
- Decaying of seeds and no emerged seeds
- Affects groundnuts sales and its by products

How to minimise Aflatoxin contamination

- Harvest crops on time once they are mature (at the correct stage of maturity)
- Minimise pod damage by insects
- Dry pods to safe moisture levels as soon as possible after harvesting
- Separate discoloured, shrivelled and damaged pods at shelling
- Store pods under dry conditions in cool and well-ventilated storage facilities
- Follow proper drying procedures
- Remove soil from pods before drying
- Good curing practices

POST-HARVEST HANDLING OF COWPEAS

Cowpeas are normally harvested when the moisture content is between 14-18%. Start harvesting early in the morning to avoid shattering losses which increase when pods become dry and brittle from the heat of the sun.

Selective harvesting can be employed on cowpeas since old pods do not stay in the harvestable conditions until the youngest pods have matured. Several hand-pickings normally spread over 2-3 weeks.

Stages in post-harvest handling of cowpeas

1. Threshing

- It is the stage that involves the separation of pods from the sheath
- Manual threshing can cause damage to seeds which in turn results in stunted plants with abnormalities.

2. Sorting or grading

Sorting is done to remove broken, damaged and immature seed from full seeds.

3. Storage

- Packing and storage is done when the moisture content is 12%
- Cowpeas are very susceptible to attack by pests that cause intense damage to the seed
- It is normally attacked by weevils (Coleoptera, Bruchidae)
- If storage is for short-term, store them when moisture content is 12%
- If storage is long term, store them when moisture content is 8-9%.

Table 4: Nutritional value of cowpeas

Nutrient	**Percentage (%)**
Protein	24.8 %
Fat	1.9 %
Fiber	6.3 %
Carbohydrates	63.6 %
Others (Thiamine, Riboflavin and Niacin)	3.4 %

POST-HARVEST HANDLING OF COMMON BEANS (SUGAR BEANS)

When to harvest common beans:

- Most leaves have turned yellow
- The drying leaves start to turn yellow
- Half the leaves turn yellow

How to harvest common beans:

- Use sickle to cut the haulms from the base
- It is advisable to harvest in the morning to avoid undue shattering
- Use selective harvesting if pods have unevenly matured

Stages in post-harvest handling of common beans

1. Drying

- Dry the common beans before threshing them.
- Threshing them before they properly dry results in damage on pods.
- Dry the pods on raised platforms, plastic, mat to avoid contact with moisture and other impurities.

2. Threshing

- It is advisable to do the threshing when the moisture level is 14-15%

- If the seeds are too dry, the pods can be easily damaged during threshing
- Thresh thee pods manually by beating with a stick
- After threshing, winnow to remove chaff

3. Grading

- After winnowing, grade the seeds to remove dust, damaged, broken and diseased seeds
- Separate the seeds by variety

4. Storage

- Store the seeds in clean or disinfected bags when the moisture content is 13-15%
- Do not mix the newly harvested grain with stocks from previous harvests
- Store the bags at least 1 meter away from the walls and on a raised platform
- Store the bags in a non-leaking storehouse to avoid contact with moisture

5. Treatment

- Treatment is done to protect the seed from damage by insect during storage
- If thee grain is going to be stored for longer periods, it is advisable to use chemical treatment but with care
- The recommended chemicals for treating commons beans are:
    a) Actellic powder
    b) Shumba
    c) Chirindamatura

Pests for common beans

- The common pests for common beans are Bean brichids
- Storing grains that are poorly dried or under poor hygienic conditions can cause infestation by pests

Ways of minimising pest infestation

- Harvest before split to avoid field infestation
- Dry seeds thoroughly before storage
- Use pest resistant varieties
- Boil storage bags before using them
- Inspect stored seeds for signs of infestation and take corrective action

How to check for moisture content in common beans grains: In most cases, grain moisture content can be checked using an electronic hand held moisture meter. However, such devices are nor readily available to smallholder farmers in rural set ups. An alternative is to use the salt and glass jar approach.

Materials: Salt, Jar, Seeds

Procedure:

1. Clean the jar and dry it
2. Fill the jar to ¼ full with salt
3. Add seeds until the jar is ½ full
4. Shake the jar & allow seeds to settle for 10 minutes

Results:

- If you observe some salt sticking onto the walls of the glass jar, then grains moisture content is above the recommended 13-15% range.
- However, if you observe that the walls of the glass jar are clear, then the moisture content is within the recommended range and is dry enough for storage.

Table 5: Nutritional value of common beans

Nutrient	**Percentage (%)**
Protein	22.33 %
Fat	1.50 %
Carbohydrates	60.75 %
Others (Thiamine, Riboflavin and Niacin)	15.42 %

POST-HARVEST HANDLING OF SOYBEANS

Most of the post-harvest losses in soybeans occur during the following processes:

- Harvesting
- Winnowing
- Storage
- Processing
- Threshing
- Packaging
- Transportation
- Marketing

Ways of minimizing post harvest losses for soybean:

- Harvesting on time when moisture content is 14%
- Using proper method of harvesting
- Making use of most efficient methods for threshing and winnowing
- Avoid beating/thrashing the pods severely during threshing as it will damage the seeds
- Avoid excessive drying, fast drying and rewetting grains
- Ensure uniform drying of seeds
- Grade the pods before bagging
- Make use of good well-ventilated storage facilities
- Use moisture meter to test for moisture content level before storing
- Fumigate the storage before storing the bagged pods
- Transport pods in bags to avoid pests infestation during transportation
- Properly handle bags during loading & unloading to minimize losses

Causes of post-harvest losses in the field:

- Shattering
- Poor timing of agricultural operations
- Untimely harvest (early or late harvesting)
- Careless handling
- Birds and rodents
- Rainfall

Challenges with *<u>early</u>* harvesting:

- High population of immature seeds
- High chances of disease attack
- Low yield
- Poor quality seeds

Challenges with *<u>late</u>* harvesting:

- Exposure to insects, birds and rodents
- Grain shattering
- Cracking of grains

Stages in post-harvest handling of soybeans

1. Grading

- Separate grains by variety
- Remove broken diseased and damaged pods before storing
- Make sure that you only bag good quality produce (no discoloured, impurities, high moisture content or admixture)

Importance of grading:

- To get good quality grains
- To fetch higher prices for produce
- To minimise storage and handling costs
- To create good relationships with buyers

2. Storage

- Select well-ventilated storage facilities
- Cleans bags before using them for storage
- Store separately old and ne grain stock
- Do not store soybeans in compartments with cement, fertiliser or other chemicals with odour

3. Preservation

- Make sure that you bag soybean at a moisture level of 9% or less
- Fumigate storage facilities with Aluminium Phosphate
- Do not use methyl bromide since soybean is high in oil

Storage pests and control mechanism

The chemicals that are used to treat soybean vary from country to country depending on availability. It is advisable to consult your extension agent for the names of chemicals that you can use.

Table 6: Soybean pests and common treatments

Pest	**Possible control mechanism**
Cigarette beetle	Malathion 50% EC
Leser grain bore	Malathion 50% EC
Saw toothed grain beetle	DDVP
Groundnut borer	DDVP

Rodents

- Cause physical damage to grains
- Excreta deteriorate quality of produce

Control of rodents: Use rat cages, Zinc Phosphide or Aluminium Phosphide

Dos and don'ts when harvesting soybean:

- Do not harvest in wet conditions
- Use proper and efficient methods of harvesting
- Separate grains by variety, that is keep true to type
- Dry the harvested grains for 8-10 days
- Avoid direct sun drying as it increases breaking of seeds
- Transport the pods in bags

Table 7: Soybean quality standards

Moisture content	12%
Damaged seeds and weeviled	3%
Foreign matter and impurities	4%
Mechanically damaged (split, broken & crack)	2%
Shrivelled	5%

Source: NAFED, 2004

Table 8: Nutritional value of soybeans

Component	**Percentage (%)**
Proteins	40 %
Carbohydrates	30 %
Fats/Oil	18-20 %
Others	10 %