

GOOD AGRICULTURAL PRACTICES, POST-HARVEST HANDLING AND TRADE REQUIREMENTS IN THE GROUNDNUT VALUE CHAIN IN KENYA



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GROUNDNUT VALUE CHAIN**

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FOREWORD

The European Union (EU) in partnership with the East African Community (EAC) launched the Market Access Upgrade Programme (MARKUP) to support member countries improve market access of agro-food products to the EU and regional markets. UNIDO is the implementation partner for the Kenya-Partner States Window. The sub-sectors of interest in the MARKUP program include: French beans, groundnuts, macadamia nuts, snow peas and peas, mangoes, passion fruit, chilies, herbs and spices. Recent studies have analyzed the reasons for low productivity and competitiveness in these value chains and among others identified lack of specialized extension services and a diffuse lack of knowledge on appropriate good agricultural practices (GAP). These value chains also lack compliance with market requirements and standards posing a challenge to exploiting potential benefits from the more lucrative export market. The MARKUP project aims at improving the institutional and regulatory framework for better conformity assessment services in Kenya's horticultural sector; increase revenue and MARKUP for Kenya's smallholder producers and enterprises in export-oriented horticulture sectors.

The main purpose of this training manual is to contribute to the economic development of Kenya by increasing the value of both extra and intra-regional export of French beans. The training focuses on building capacity in good agricultural practices with specific focus on good agronomic practices, integrated pest and disease management, pesticide application post-harvest management in the French bean value chain as well as legal and technical requirements for export of the produce. In addition, the training manual aims at building capacity for extension officers and producers in spraying regimes with a view to promoting economical and safe use of pesticides in order to support safe trade of French beans both locally and internationally. Through this initiative, extension officers and producers will be trained; after which they will be expected roll out the learned knowledge to other extension officers and producers through in situ trainings in the major French bean producing counties in Kenya. Selection of the initial trainees (Master Trainers) is based on good understanding of food safety, production of French beans, application of pesticides, post-harvest management, export of the beans, and ability to mentor others. Overall, the training endeavors to contribute to production of high quality French beans that are compliant with market requirements under the MARKUP project in order to enhance Kenyan exports and increase market access. To achieve this, the training aims at increasing the number of extension officers and French bean growers at county level to be part of suppliers' control and monitoring plans.

At the initial stages, the trainees will be mentored by experts through a practical on-site training session followed by an independent implementation phase during which the mentee will be supported remotely. It is anticipated that the mentees will train other extension officers and farmers leading to an increase in French bean yield, improved quality of the produce, enhanced compliance with market requirements and ultimately an increase in domestic, regional and international trade.

Director General, AFA

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EXPECTED LEARNING OUTCOMES

- **Extension agents are expected to:**
 - Effectively train farmers on good agricultural practices in production of groundnuts.
 - Effectively train groundnut farmers on integrated pest management and pesticide application.
 - Effectively train farmers on post-harvest handling of groundnuts including drying, grading, storage, transportation and marketing.
 - Effectively disseminate information on aflatoxins and their management in groundnuts to farmers and other value chain actors.
 - Effectively train groundnut farmers on practices that promote compliance with market requirements and quality standards at pre-harvest and post-harvest stages.
 - Understand skills and approaches for a good trainer.

- **Producers are expected to:**
 - Have an in-depth understanding of good agricultural practices and post-harvest practices for production of quality groundnuts.
 - Understand integrated pest management and pesticide application in groundnut production.
 - Understand pre-harvest and post-harvest practices that reduce the risk of aflatoxin contamination in groundnuts.
 - Be aware of the local and international aflatoxins regulatory requirements for groundnuts.
 - Understand the role of compliance with quality standards on health and trade.
 - Have an in-depth understanding of practices that contribute to compliance with market requirements and quality standards at pre-harvest and post-harvest stages.

- **The Regulators/Inspectors are expected to:**
 - Have a good understanding of aflatoxins, their effects on health and trade in groundnuts.
 - Definitively explain the problem of aflatoxins and their management in groundnuts and groundnut products.
 - Effectively inspect and test for aflatoxins in groundnuts.
 - Have a good understanding on post-harvest handling of groundnuts including drying, grading, storage, transportation and marketing.
 - Definitively explain the steps towards compliance with standards set for groundnuts by local, regional and international markets.

ABBREVIATIONS AND ACRONYMS

CaSO₄:	Calcium sulfate
EAC:	East African Community
EU:	European Union
FAO:	Food and Agriculture Organization
FAOSTAT:	Food and Agriculture Organization Corporate Statistical Database
FYM:	Farm Yard Manure
GAP:	Good Agricultural Practices
GMP:	Good Manufacturing Practices
HACCP:	Hazard Analysis Critical Control Point
IITA:	International Institute of Tropical Agriculture
ISID:	Inclusive and Sustainable Industrial Development
MARKUP:	Market Access Upgrade Programme
SDGs:	Sustainable Development Goals
SSP:	Single Super Phosphate
TSP:	Triple Super Phosphate
UN:	United Nations
UNIDO:	United Nations Industrial Development Organization
WHO:	World Health Organization

1. GENERAL ASPECTS OF GROUNDNUTS

Groundnut (*Arachis hypogaea*) also known as peanut or monkey nut is a legume grown mainly for its edible seeds. It is widely grown in the tropics and subtropics as an important to both smallholder and large commercial producers. It is classified both as a grain legume and due to its high oil content, an oil crop. Atypically among legume crop plants, groundnut pods develop underground (geocarpy) rather than above ground. With this characteristic in mind, the botanist Carl Linnaeus gave groundnuts the specific epithet hypogaea, which means “under the earth”. Like most other legumes, groundnut harbours symbiotic nitrogen-fixing bacteria in root nodules. The capacity to fix nitrogen means the crop improves soil fertility, requires less application of nitrogen-containing fertilizers and is therefore valuable in crop rotation programs.

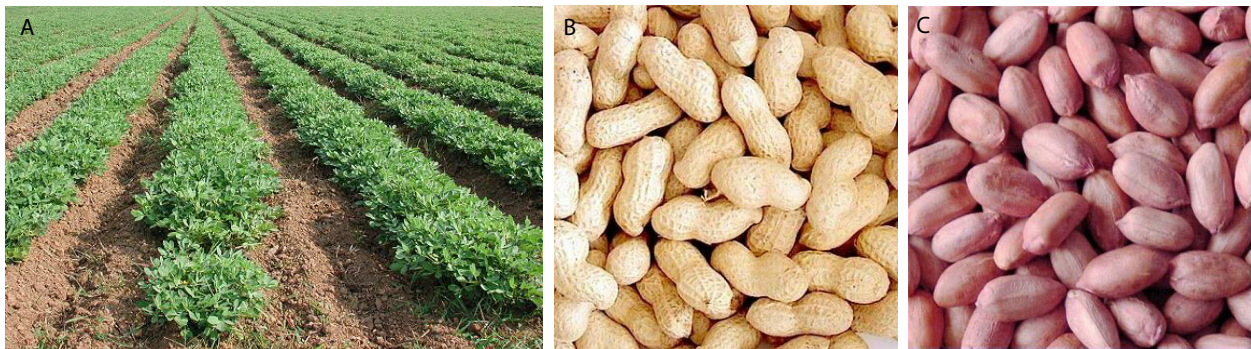


Figure 1: A groundnut crop growing in the field (A), mature groundnuts in shell (B) and groundnut seeds (C)

Photo Credit: Agri Farming (A), Indiamart (B and C)

1.1 STATUS OF GROUNDNUT PRODUCTION IN KENYA AND EXPORT OPPORTUNITIES

Groundnut is the sixth most important oilseed crop in the world. In Kenya, groundnuts are mainly grown in Western Kenya by smallholder farmers for both food and sale. Between 2017 and 2019, groundnut exports from Kenya increased by 203 per cent to 118 tonnes earning the country US\$ 0.06m in 2019. Table 1 summarizes trends of production and value of groundnuts in Kenya from 2010 to 2019. However, the annual growth of Kenya groundnuts in value between 2015 and 2019 was -11% per year, while the annual growth in quantity through the same period was -12% per annum. Although Kenya exports some groundnuts, this implies that the country is a net importer of groundnuts. The leading export markets for Kenya groundnuts are highlighted in Table 2.

Table 1: Production quantity (tonnes) and value (USD) of groundnuts in Kenya from 2010 to 2019

Year	Quantity (tonnes)	Value (USD)
2010	122	122
2011	98	103
2012	18	30
2013	302	142
2014	67	36
2015	135	307
2016	20	11
2017	39	5
2018	5	4
2019	118	61

Source: FAOSTAT

Table 2: Leading export markets for Kenya groundnuts (in '000\$) from 2010 to 2019

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
DR Congo										49
Uganda	7			247	1	2	16	37		12
South Sudan								2	5	2
Cameroon								1		
Sri Lanka						36				
Somalia	251			30						
Malaysia				15						
Netherlands						35				
Sudan	1									
Serbia				1						

1.2 MAJOR GROUNDNUT PRODUCTION REGIONS IN KENYA

Groundnuts are mainly grown in western Kenya and the coastal region (Figure 2) by small-scale farmers both for food and sale. These areas have a tropical climate suitable for groundnut production.

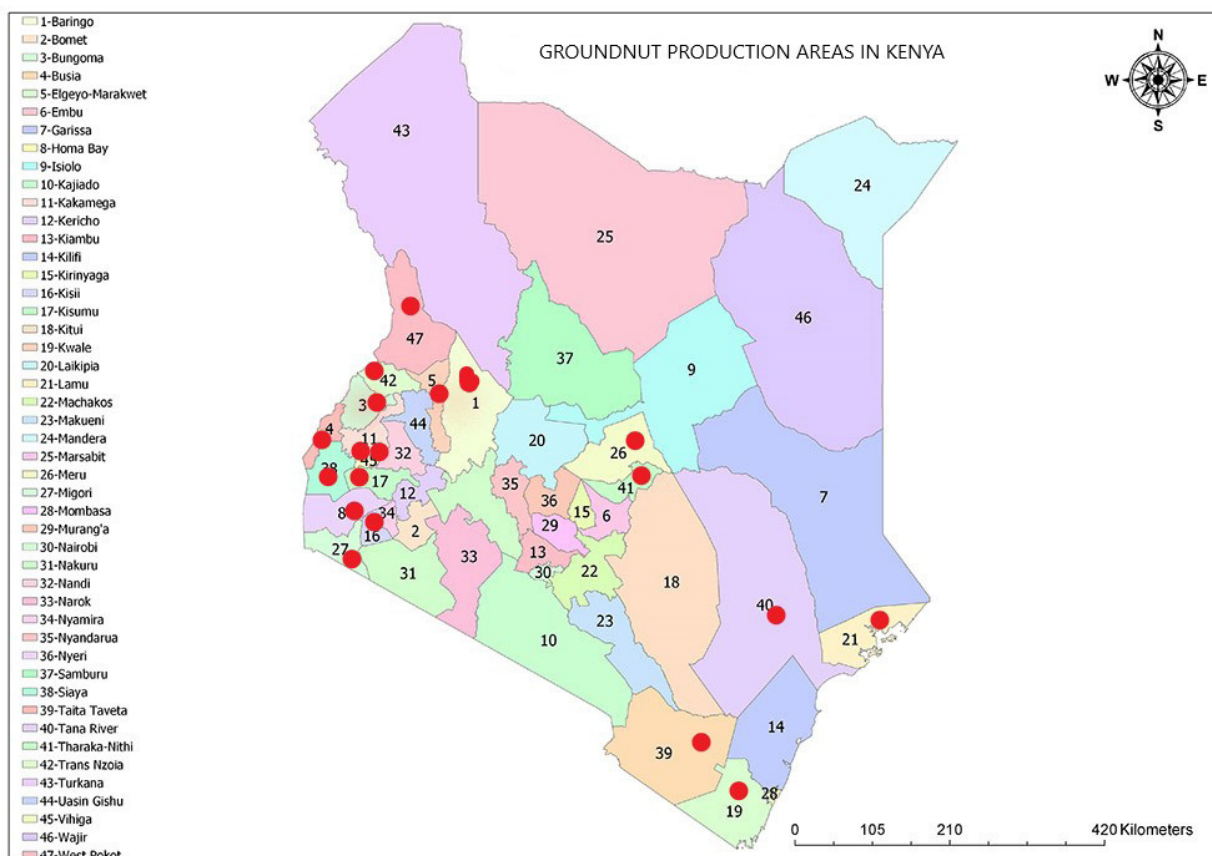


Figure 2: Map of Kenya showing the major groundnut production regions, highlighted in red

1.3 CATEGORIES AND VARIETIES OF GROUNDNUTS GROWN IN KENYA

There are two main categories of groundnuts grown in Kenya:

- i. **The runner type** (e.g. variety Homa Bay) - The runner type is the larger variety and is preferred by farmers because of its high yields; and relatively fast maturity in 120 – 150 days. These varieties have an attractive uniform kernel size and are most commonly used in the production of peanut butter.
- ii. **The bunch type** (mainly variety Red Valencia) - Bunch varieties are small, tastier and are highly marketable. They are bright red in color and mature in 90 to 100 days. They are known as the sweetest tasting groundnuts and are, therefore, popular for all natural and homemade peanut butters. They are usually roasted, sold in shell and also make delicious boiled groundnuts.

The present yield of groundnut growers in Kenya ranges from 450 to 700 kg per hectare compared to the global average of 2500–2700 kg per hectare. These yields are low but can be doubled through improvement of husbandry practices.



Figure 3: Runner and bunch type groundnut plants (A), and the corresponding kernels of the two types (B and C)

Photo Credit: Kayam *et al.*, 2017 (A), Oklahoma Peanut Commission (B and C)

The groundnut varieties commonly grown in Kenya include:

- Red Valentia
- Red Oriata
- Homa Bay
- Manipinta
- Makulu Red
- Bukene
- Texas Peanut
- Atika
- Asirya Mwitunde
- Severe

1.4 CLIMATIC REQUIREMENTS

Groundnuts grow well in warm areas below 1500 meters above sea level with temperatures ranging from 28 to 30 °C. Low temperatures affect flowering and seed formation in the crop. The lower limit for germination of groundnuts is around 18°C; with higher temperatures between 20 and 30°C resulting in 95% germination. However, at 33°C germination declines to 84%. The warmer the environment, the faster the plant reaches the reproductive phase. Flower formation is closely related to mean daily temperature on condition that the variation between day/night temperature does not exceed 20°C. The most flowers are formed at a day temperature of 27°C, while a warm day (29°C) and a cool night (23°C) gives the highest pod formation. Groundnuts require 500 to 600 mm of rainfall which is well-distributed throughout the growing season. The crop can survive drought or reduced rain but yields will be low.

1.5 KEY CHALLENGES IN THE GROUNDNUT VALUE CHAIN IN KENYA

The current inefficiencies in groundnut value chain in Kenya negatively impact household food security and income generation potential for smallholder farmers. Some of the challenges in the groundnut value chain in the country include:

- i. Accessibility to clean planting seed
- ii. Accessibility to high value markets mainly due to low production and high aflatoxin contamination
- iii. High costs associated with shelling
- iv. Poor post-harvest handling - In Kenya, 20-30% of groundnut yield is lost during and after harvesting. This is mainly attributed to lack of adequate and appropriate information on the best and effective practices in post-harvest handling of the crop
- v. Poor storage practices - Being an oilseed, groundnut storage environment and handling practices are of utmost importance thus requiring heightened interventions
- vi. Aflatoxin contamination – The climatic conditions in groundnut production regions in Kenya are warm and humid providing an ideal environment for proliferation of aflatoxin producing fungi. Coupled with poor handling and storage practices, groundnuts produced in the country are at a high risk of aflatoxin contamination.

1.6 CHALLENGE OF GROUNDNUTS CONTAMINATION WITH AFLATOXINS

Aflatoxins are highly toxic substances produced by certain species of molds, mainly *Aspergillus flavus* and *Aspergillus parasiticus* and to a lesser extent *A. nomius*, *A. pseudotamarii* and *A. bombycis* (Klich, 2007). The aflatoxin producing fungi which are naturally found in the environment, maintain an intimate association with crops, leading to aflatoxin production during every stage of the value chain: pre-harvest, at harvest and post-harvest phases. Once produced, aflatoxins remain in the crop for the subsequent parts of the value chain until consumption. Aflatoxins also contaminate other crops including: maize, tree nuts, herbs and spices.

Aflatoxins are abundant in warm and humid regions of the world. The aflatoxin producing molds infect the crop pre-harvest and could continue to produce aflatoxins post-harvest when conditions of moisture and temperature are right. Aflatoxins, secreted in minute quantities, contaminate groundnuts in the soil when the crop is still in the field, and also during the drying process. Drought (water stress) and rain during harvesting increase the risk of aflatoxin contamination during production. Drought stresses the plant making it more susceptible to attack by the fungus; while rains during harvesting and drying create ideal climatic conditions for growth of the fungus. Harvesting in wet conditions should therefore be avoided to minimize the risk of aflatoxin contamination.

Aflatoxins are considered an important public health concern and can seriously affect human health and livelihoods. Aflatoxin contamination remains a challenge throughout the food chain, and since freedom of choice in food is limited for a poor and food-insecure population, exposure to aflatoxin is widespread and consumers in developing countries are at risk from aflatoxin-related illnesses. It is estimated that more than five billion people worldwide are at a risk of chronic exposure to aflatoxins (Williams *et al.*, 2004).

Sun drying the groundnuts is often the only option for smallholder farmers, and it entails spreading the produce out on the soil where inoculum of the fungus is found. The risk to public health is also an issue when consumers consume groundnuts or groundnut products that have not been tested for aflatoxin levels. These complex challenges particularly have an impact on small-scale farmers and poor consumers in low-income countries.

Contamination of foods (including groundnuts) with aflatoxins results in adverse health effects and loss in trade. The key challenges to effective management of aflatoxins in Kenya include:

- i. A significant proportion of resource constrained smallholder farmers who may not be willing to invest in management efforts
- ii. Informal marketing structures that make compliance monitoring difficult or non-existent
- iii. Weak regulatory framework
- iv. Limited knowledge about the problem of aflatoxins and appropriate management strategies
- v. Poor adoption of available solutions
- vi. Absence of approved and robust surveillance approaches
- vii. Warm tropical and sub-tropical climate, which favours proliferation of aflatoxin producing fungi and aflatoxin production compared to cool parts of the world

2. PRODUCTION OF GROUNDNUTS

2.1 SOIL REQUIREMENTS

- Groundnut can grow in all soil types, other than very heavy soils
- However, the best soils are deep, well drained sandy or sandy loam
- Sandy soils facilitate the forcing of the developing fruit into the soil (pegging)
- Groundnut does not grow well or fix nitrogen in acidic or infertile soils
- The ideal pH for growth of groundnut is between 5.3 and 7.3
- Groundnut plants are sensitive to salinity, while high soil acidity (pH<5) could induce magnesium or aluminum toxicity
- In acidic soils, calcium should be added to maintain the pH above 6

The groundnut plant produces runners (horizontal stems) which in turn produce flowers at each node. These flowers self-pollinate and produce an anchor or peg which penetrates the ground. The groundnut pod is produced underground at the tip of the pegs. Therefore, it is important that the topsoil must have a low clay content (less than 20%) with a loose structure so that the peg may penetrate the soil freely. Soils with a high clay percentage in the topsoil may cause the groundnut pegs to break at harvest. Soil compaction can also be a problem if the fine sand fraction of the topsoil is high. This situation can be aggravated in soils where the organic residues are low.

The seedbed should be deep, without compaction layers, to accommodate the groundnut plant's root system. Shallow soils should be avoided due to the low water retention capacity, as well as the possibility of water logging. Soils with a high potential for the production of groundnuts are thus typically deep (900-1200 mm), structureless yellow, yellow-red or red with a sandy loam to sandy texture in the topsoil, without physical limitations, such as compaction.

The ideal PH requirement for production of groundnuts ranges from 5.3 to 7.3. Maintaining soil pH is important as it affects the availability of nutrients to plants. In case the pH is <5, lime in appropriate form and quantity should be mixed thoroughly into the soil before land preparation or at the time of land preparation so as to bring it into the optimal range. The rate of application of lime depends upon the type of lime, soil type and depth of application. As a general recommendation, 1.5 tonnes per hectare of lime is required to raise the soil pH from 5.0 to 6.5.

2.2 PRE-PLANTING ACTIVITIES AND CONSIDERATIONS

2.2.1 ROTATION

- To avoid the build-up of pests and diseases, groundnut should not be grown continuously on the same land
- A rotation of 3 years or longer usually reduces disease, pest and weed problems
- Groundnut does well on virgin land or immediately following a grass fallow or a well fertilized cereal crop such as maize, sorghum or millet
- Groundnut fits into a wide range of farming systems
- It can follow cereals (maize, pearl millet and sorghum) or it can be intercropped with root crops such as cassava and sweet potatoes
- Cereals, such as maize, sorghum and millet are particularly good groundnut rotational crops
- Other legumes, tobacco, tomato and certain other vegetables such as lettuce and okra may cause a build-up of nematodes and soil-borne diseases and, therefore, should be avoided in rotation with groundnuts
- To reduce the incidence of pests and soil-borne diseases, groundnut should not be grown after cotton, although cotton can be used in rotation after groundnut

2.2.2 SELECTION OF PRODUCTION SITE

- i. An ideal groundnut production site should have soil that is well drained, light-colored, loose, friable, sandy loams that contain high levels of calcium and a moderate amount of organic matter
- ii. Optimum groundnut production occurs on land with a topsoil depth of 1.5 to 2 feet with a friable sandy loam or clay loam subsoil
- iii. Avoid planting peanuts in fields with shallow topsoil or in poorly drained areas
- iv. The best pH for growing groundnuts ranges from 6.0 and 6.3

2.2.3 LAND PREPARATION

- The field should be cleared of all stubble and plant residues of the previous crop. Un-decomposed plant residues promote growth of disease-causing soil borne fungal pathogens
- Plough the land and harrow to a good tilth
- The recommended ploughing is to a depth of 15-20 cm (very deep ploughing should be avoided) and several passes of the harrow to obtain a fine texture
- Groundnut can be sown on flat beds or ridges or raised beds separated by furrows
- Prepare ridges which are 80cm apart with flattish tops
- Sowing on raised beds with 0.4-0.8% slope allows ridges flat beds easy drainage of excess water
- This also helps avoid compaction of seed beds and facilitates field operations as all movements are restricted to the furrows



Figure 4: Neatly prepared land – with ridges and furrows - for planting groundnuts under rainfed (A) and drip irrigation (B) systems

Photo Credit: John C. French Sr. (A), ICAR (B)

2.2.4 TIMING OF PLANTING

- The planting date is difficult to standardize. However, farmers should plant as soon as there is adequate moisture in the ground to ensure good germination
- In general, groundnuts are planted in Kenya between February and April during the long rain season and in early August for the short rain season
- Planting in the first two weeks after the onset of rains is considered suitable
- Planting early in the season helps to improve yields and seed quality, and reduce the incidence of rosette disease
- Long duration varieties should only be planted with the first rains in the long rain season
- Short duration varieties can be planted in either season

2.3 PLANTING

2.3.1 SEED DRESSING

- To control seedling blights caused by soilborne bacteria and fungi, and other fungal diseases such as damping off, a fungicide treatment of groundnut seeds for planting is recommended
- Thiram (or any other fungicide that contains dimethyldithiocarbamate) gives good protection and can be applied as a dust at a rate of 120 g /100 kg of seed
- The dust must be uniformly mixed with the seed

2.3.2 SPACING AND SEED RATE

- Spacing depends on the variety and its growth habit
- Small seeded Spanish types (bunch) are spaced at 30-45 cm between rows and 15-20 cm between plants
- This gives an optimum plant population of 66,000 per acre, which is equivalent of at least 16 kilos of seed
- The large-seeded Virginia types (runner) are spaced at 60 cm between rows and 10-15 cm between plants, giving an optimum plant population of 36,000 per acre
- Under irrigation, plant population can be as high as 100,000 plants/acre
- This depends on variety characteristics, seed quality and planting density
- Planting groundnut plants closer together results in individual plants setting fewer pods, but over a shorter period of time
- Overall, this will ensure that the pods will be of a similar age and stage of development and, therefore, makes it easier to decide when to harvest
- Wider spacing results in lower yield per unit of production
- With manual sowing, individual seeds are sown 3-5 cm deep

To ensure uniform sowing depth, germination and crop stand, it is suggested that a groove that is 5–6 cm in depth is made along the rows for planting and, once the seed has been planted at the right depth and spacing, the soil is pressed down to ensure good contact with the seeds, enabling them to extract moisture more effectively. It is important to sow groundnut seeds in rows and at the right spacing as this helps:

- i. To reduce the incidence of rosette disease
- ii. Ensures a more uniform pod maturity and better quality seed
- iii. Maximizes yield

Overall, to obtain high quality groundnut produce, the following practices are important during planting:

- i. Plant certified seed purchased from a reliable source, which is pure (true to type), graded (medium-size), undamaged, fully developed and healthy (free from discoloration and fungal infection) with germination above 90%
- ii. Germination test on seeds should be carried out one week before sowing and the seed rate should be adjusted accordingly



Figure 5: Properly spaced groundnut crop planted in straight rows in the field

Photo Credit: Groundnuts Production guide for Uganda (A), Bakhabar Kissan (B)

2.4 MANURE AND FERTILIZER REQUIREMENTS

- Before any fertilizer/manure application, soil testing should be conducted to enable the farmer make an informed decision
- Groundnut responds to residual soil fertility better than the direct application of fertilizers. The crop(s) preceding groundnut should be well fertilized to build up soil fertility particularly for phosphorus (P) and potassium (K)
- Application of fertilizers and their dose should be based on the nutrient status of the soil as determined by the soil test and the targeted yield
- However, a reasonable level of organic matter must be maintained in the light, weakly structured, tropical soils where groundnuts are grown
- Groundnut requires adequate levels of phosphorus, potassium, magnesium and particularly calcium, which are required for maximizing yield and good quality seed
- Where fertilizer application is required (based on results of soil analysis), application of Single Super Phosphate (SSP) at the rate of 100 - 125 kg/ha or Triple Super Phosphate (TSP) at 80 - 90 kg/ha will boost yield
- SSP or TSP should be ploughed into the soil before planting
- High incidence of empty pods ('pops') is an indicator of likelihood of a shortage of calcium in the soil
- To rectify this, depending on the soil type and seed variety, a treatment of gypsum (calcium sulfate, CaSO_4) at the rate of 200 - 400 kg/ha (up to 500 - 1000 kg/ha if the soil is particularly poor) at early flowering will reduce the incidence of empty pods
- However, general recommendations for groundnut fertility management are as follows:

2.4.1 MANURE

- Farm yard manure (FYM) or Compost: 10-12 t/ha; 25-30 days before sowing
- Introducing green manure in crop rotation also helps to increase the organic matter content of the soil and improve its structure

2.4.2 MACRONUTRIENTS

- **Nitrogen (N), Phosphorus (P) and Potassium (K):** 8-20 N, 16-80 P_2O_5 , 0-75 K_2O kg/ha, respectively; as basal application

- **Calcium (Ca):** 200-400 kg/ha of gypsum at the peak flowering stage as side placement (top dressing). Calcium is essential for good seed development

2.4.3 MICRONUTRIENTS

Many groundnut production fields are deficient in micronutrients – boron, zinc and sulphur. If soil test shows deficiency of these micronutrients, remedial measures should be taken as follows:

- **Boron (B):** Apply 3-4 kg/ha borax to the soil at the time of land preparation. The residual effect of borax should last several seasons. Alternately, 0.1% borax can be sprayed on the crop early in the season to ensure boron uptake before flowering.
- **Zinc (Zn):** Apply 10-20 kg/ha Zinc sulphate to the soil once in three years at the time of land preparation.
- **Sulphur (S):** Application of gypsum provides adequate sulphur to the crop. Sulphur deficiency is most likely to occur on very sandy soils, which possess little anion exchange capacity.
- **Iron (Fe):** In many calcareous soils (soil that has calcium carbonate (CaCO₃) in abundance), groundnut plants show iron deficiency symptoms (interveinal chlorosis in young leaves followed by full chlorosis [whitish yellow] of entire leaves). Iron chlorosis can be alleviated by applying ferrous sulphate at the rate of 10 kg/ha to the soil or spraying the affected crop with 0.5% ferrous sulphate + 0.2% urea solution. If required, the spray treatment could be repeated at 10-14 days interval.

2.5 WATER REQUIREMENTS

- For a rainfed groundnut crop, the production site should have good drainage to ensure that excess rain water does not stagnate in the field
- If supplementary irrigation is available, water analysis should be carried out to determine safety of the water both in terms of nutrient and microbial status
- Irrigation should be done at critical growth stages such as flowering, pegging and pod and seed development
- Generally, 600-650 mm of water is sufficient to raise a full groundnut crop
- A 2-3 week moisture stress soon after crop emergence followed by regular irrigation, often helps in inducing profuse flowering and uniform pod maturity
- At pegging and pod and seed development stages, light but frequent irrigation is required
- Excessive irrigation at later stages of crop growth may promote pod and seed diseases at maturity
- The preferred method of irrigation is sprinkler or drip irrigation
- Flood irrigation, is not a good method of irrigation as it wastes water, results in over watering and trampling of plants in the field by workers engaged in irrigation
- Temperature of the water absorbed by the seed is critical for germination of groundnuts
- Planting in dry soil followed by irrigation with cold water should therefore be avoided
- Planting in cold wet soil is therefore unsuitable; while planting in warm soils results in faster germination and healthy seedlings



Figure 6: Groundnut production under sprinkler (A) and furrow irrigation (B)

Photo Credit: AgriFarming (A), ICAR-Indian Institute of Water Management (B)

2.6 WEED MANAGEMENT

- Groundnut cannot compete effectively with weeds, particularly 3 to 6 weeks after sowing; therefore, early removal of weeds is recommended
- It is essential to keep groundnut fields free off weeds for up to 45 days after crop emergence
- Even at later stages, it is desirable not to have weeds in the field as they interfere with harvesting
- Generally, 2 weedings are recommended, the first before flowering and another during pegging stage
- If early weeding is done well and crop spacing recommendations followed, then the weeds that come up later are smothered with the vigorous growth of the crop
- If necessary, pay extra attention when walking through a flowering groundnut field in order not to disturb the flowering plants
- The plant should not be disturbed once the pegs enter the soil
- Inter-cropping groundnuts with another crop in a rain-fed production system helps to reduce weeds and also encourages infiltration of rainwater
- Many farmers practice earthing up (mounting soil around the plant), to allow pegs from higher nodes to enter the soil. This practice is not recommended as it may promote infection by stem rot causing fungus. It also deteriorates the quality of earlier set mature pods while waiting for the later set pods to mature

2.6.1 WEEDING BY HAND

- Once flowering and pegging begins, it is advisable to weed the groundnut crop by hand pulling, rather than by using a hoe, as this is less likely to disturb any developing pods
- When weeding, it is very important to avoid covering the developed plant with earth (including earthing up) as this can increase disease infection (e.g. white mold), reduce flowering and pod development and pod yield
- The last hand weeding can be done along with gypsum application so as to incorporate it in the soil

2.6.2 USE OF HERBICIDES

- Pre- and post-emergence herbicides may be used to eradicate weeds but they are expensive for most small-scale farmers
- Where herbicides are used, follow the manufacturers' instructions with regard to dosage and whether the herbicide is pre or post-emergence
- Application of pre-emergence herbicides such as pendimethalin at 1.0 - 1.5 kg a.i./ha as spray or fluchloralin at 1.0 -1.5 kg a.i./ha as pre-plant soil incorporation can be done as part of weeding



Figure 7: Unweeded groundnut field (A) and a weed free groundnut field (B)

Photo Credit: ICRISAT (A), Getty Images (B)

3. MAJOR PESTS AND DISEASES OF GROUNDNUT AND THEIR MANAGEMENT

3.1 MAJOR PESTS AND DISEASES OF GROUNDNUT



Groundnuts are highly susceptible to various pests and diseases at all growth stages. Termites, aphids, white grubs and millipedes attack roots, stem bases, leaves and pods. However, termites, aphids, thrips and leaf miner are the most important pests of groundnut.



The major insect pests that attack groundnut can be grouped as:




- i. Soil-inhabiting insects e.g. termites, white grubs, earwigs, subterranean ants
- ii. Foliage feeding insects e.g. leaf miner, caterpillars, armyworm, bollworm
- iii. Those that transmit viral diseases e.g. thrips, aphids
- iv. Insects that damage flowers and growing parts e.g. blister beetle



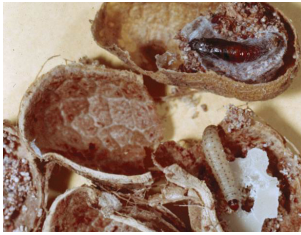
There are numerous diseases that affect groundnut. However, rust and groundnut rosette virus account for approximately 80 percent of groundnut damaged while on the farm. *Aspergillus flavus*, common in the soil flora, has often been associated with seed and seedling diseases of groundnut; but is especially important because of the ability of certain strains to produce aflatoxins on groundnuts. Other important diseases of groundnut include leaf spots and damping off disease.



Table 3: Common pests and diseases of groundnut, their symptoms and management practices

A. INSECT PESTS				
Pest	Description	Key symptoms	Management practices	Image and photo credit
Thrips <i>(Megalurothrips sjostedti and Frankliniella schultzei)</i>	<ul style="list-style-type: none"> • Thrips are small (1.5 mm) and slender • Adult thrips are pale yellow to light brown • Nymphs are smaller and lighter in colour • Thrips mainly infest buds and flowers • They transmit viruses to groundnuts including peanut bud necrosis virus 	<ul style="list-style-type: none"> • Attacked flowers are discoloured and scarred • Terminal leaf buds are blackened and distorted after unfolding • Thrips feeding causes yellowish-green patches on the upper leaf surface and brown necrotic areas and silvery sheen on the lower surface of the leaf • If population is high, leaves may be distorted • Leaves are covered in coarse stippling and may appear silvery 	<ul style="list-style-type: none"> • Plough and harrow before planting to kill pupae in the soil • Use adequate plant spacing to avoid overcrowding • Provide plants with adequate irrigation and fertilization to encourage fast establishment of seedlings • Conserve natural enemies such as predatory thrips, lacewings and predatory bugs • Where necessary spray the crop with botanicals such as neem • Apply recommended insecticides in case of heavy infestation 	 <p>PC: John C. French Sr</p>  <p><i>Thrips damage on groundnut</i> PC: Steve L. Brown</p>




<p>Groundnut leafminer (<i>Protaetia modicella</i>)</p>	<ul style="list-style-type: none"> • The moth lays eggs on the underside of the groundnut leaf and petioles • Yellowish green caterpillars hatch, tunnel into the leaves and feed between the upper and lower epidermis of the leaf 	<ul style="list-style-type: none"> • Mined leaves become distorted within a few days • When the caterpillar becomes too large to occupy the mine, they emerge to the leaf surface and either fold over a single leaf and hold it down with silk, or web together two or more leaflets • Damaged leaves become brownish, rolled and dry, which results in early defoliation of the plants 	<ul style="list-style-type: none"> • Practice crop rotation • Plant during the short rain season when the miner population is normally low • Tilling the field before planting to bury crop debris in order to destroy the pupa stage • Avoid drought stress by irrigating or early sowing so as to avoid periods when drought is likely • Ensure proper fertilization for a healthy crop • Maintain the field weed free • Plant decoy crops in the field such as black nightshade • Conserve natural enemies such as parasitoid wasps and lacewings • Use tolerant/resistant varieties (if available) 	 <p><i>Damage caused by leafminer on groundnut leaves</i> PC: Plantix</p>  <p><i>Leaf miner larva</i> PC: NBAII</p>
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<p>Aphids (<i>Aphis craccivora</i>)</p>	<ul style="list-style-type: none"> Aphids are more serious in the dry season The groundnut aphid is black or dark brown in colour, variable in size (1.5 to 2.0 mm long) with two black cornicles (horns at the rear of the body), and a black tail It is a serious vector of virus diseases, such as the rosette virus disease 	<ul style="list-style-type: none"> Leaves are curled Leaves are pale yellow to green Leaf petioles are shortened Plant growth is severely stunted Early infestation of plants may result in production of very few pods Honeydew produced by aphids is deposited on the plants and encourages the growth of sooty moulds which restrict photosynthesis 	<ul style="list-style-type: none"> Practice crop rotation Early planting Conserve natural enemies such as ladybird beetles Use neem seed or leaf extracts if necessary Use tolerant or resistant varieties (if available) 	 <p><i>Groundnut aphid colony</i> PC: James Litsinger</p>  <p><i>Aphids on a groundnut leaf</i></p>
<p>Root knot nematode (<i>Meloidogyne</i> spp.)</p>	<ul style="list-style-type: none"> Galls can appear as quickly as a month after planting Nematodes cause greater damage in sandy soils 	<ul style="list-style-type: none"> They cause gall or knot formation on roots Galls on roots which are up to 3.3 cm (1 in) in diameter but are usually smaller Reduction in plant vigor Plant stunting Yellowing plants which wilt in hot weather 	<ul style="list-style-type: none"> Practice crop rotation with cereal crops Plant resistant varieties if nematodes are known to be present in the soil Soil solarizing can reduce nematode population in the soil and levels of inoculum of many other pathogens 	 <p><i>Root-knot nematode showing severe galling on groundnut</i> PC: Mactode Publications</p>





<p>Armyworms (<i>Spodoptera</i> spp.)</p>	<ul style="list-style-type: none"> • Young larvae are pale green to yellow in color • Older larvae are generally darker green with a dark and light line running along the side of their body and a pink or yellow underside • Armyworm can go through 3–5 generations a year 	<ul style="list-style-type: none"> • Singular, or closely grouped circular to irregularly shaped holes in foliage • Heavy feeding by young larvae leads to skeletonized leaves • Egg clusters of 50-150 eggs may be present on leaves • Egg clusters are covered in a whitish scale which gives the cluster a cottony or fuzzy appearance 	<ul style="list-style-type: none"> • Early planting • Plant early maturing varieties • Use natural enemies which parasitize the larvae • Application of <i>Bacillus thuringiensis</i> • Insecticides available do not provide adequate control of the larvae 	 <p><i>Armyworm larva feeding on leaves</i></p>  <p><i>Armyworm eggs on groundnut leaves</i> PC: John C. French Sr</p>
<p>Moths and beetles</p>	<ul style="list-style-type: none"> • The larvae range from 1.5 mm to 1.5 cm (15 mm) in length and are light brown in colour with dark brown spots on the skin (cuticle) 	<ul style="list-style-type: none"> • The larvae of moths and the grubs and adult beetles bore into and damage seeds • Moths cause extensive webbing 	<ul style="list-style-type: none"> • A good post harvest pest management program based on good storage practices is very important • Leaving groundnuts in the shell for as long as possible during storage is an effective method of limiting damage 	 <p><i>Dried currant moth in a groundnut pod</i> PC: Clemson University</p>





<p>Termites (<i>Microtermes</i> spp. and <i>Odontotermes</i> spp.)</p>	<ul style="list-style-type: none"> • They attack and invade growing groundnut plants through the roots and stem near ground level, hollowing them out causing the plant to wilt and die with a consequent reduction in crop stand • Termite damage is generally most serious towards the end of the growing season just prior to harvesting • Damage is particularly serious during periods of drought 	<ul style="list-style-type: none"> • Scarification of pods is the most common type of termite damage at plant maturity, a factor often aggravated by late harvest • They enter the root system and burrow inside the root and stem • Termites may cut off stem bases killing the plant • As the crop ripens the outer layers of the pods are scarified (removal of soft corky tissue between the veins of the pod) by termites allowing contamination of the seed with soil fungi, such as <i>Aspergillus flavus</i>, which produce aflatoxins 	<ul style="list-style-type: none"> • Remove residues of previous cereal crops (sorghum, millet and maize) which serve as food for termites • Early planting to avoid drought • Timely planting to avoid delay of the crop in the field • Destroy termite nests and ensure removal of queen termites • Seed treatment with Chlorpyrifos • Drenching of termite nests with Chlorpyrifos solution • Application of Carbofuran or Chlorpyrifos to the soil using 1 kg a.i. /ha at planting time can reduce termite incidence 	 <p><i>Termites enter the root system and burrow inside the root and stem</i></p>  <p><i>Termites bore holes in the pods and damage the seed</i> PC: Agropedia</p>
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B. DISEASES

Disease	Description	Key symptoms	Management practices	Image and photo credit
<p>Damping-off diseases (<i>Pythium</i> spp., <i>Rhizoctonia solani</i>)</p>	<ul style="list-style-type: none"> Damping-off diseases affect the initial establishment of a crop They are favoured by excessive wetness of the soil and low soil temperatures 	<ul style="list-style-type: none"> Poor emergence and death of seedlings leading to poor crop stand in the field Seeds may rot before germination Affected seedlings that have emerged from the soil show water-soaking, browning and shriveling of the stem at the soil level Seedlings eventually fall over and die 	<ul style="list-style-type: none"> Use certified disease-free seeds Practice crop rotation Avoid over-irrigation Avoid excessive fertilization with nitrogen fertilizers Avoid fields previously planted with cotton or other related crops 	 <p><i>Damping-off in groundnut</i> PC: Clemson University</p>  <p><i>Damping-off symptoms in groundnut</i></p>
<p>Early leaf spot (<i>Cercospora arachidicola</i>)</p>	<ul style="list-style-type: none"> Disease emergence is favored by high humidity and warm temperatures Spread of the disease is promoted by prolonged leaf wetness 	<ul style="list-style-type: none"> Small chlorotic flecks on leaf petioles, stems and pegs which enlarge and turn dark in color Lesions on upper surface of leaves usually possess a yellow halo and are reddish brown on the underside of leaves 	<ul style="list-style-type: none"> A 2-3 years crop rotation program involving cereals Plough groundnut crop debris into the soil after harvest Remove any volunteer plants from the field Plant tolerant / resistant varieties, if available 	 <p><i>Symptoms of early leaf spot on groundnut leaves</i> PC: Clemson University</p>

<p>Late leaf spot (<i>Cercospora personatum</i>)</p>	<ul style="list-style-type: none"> • Disease emergence is favored by high humidity and warm temperatures • Spread of the disease is promoted by prolonged leaf wetness 	<ul style="list-style-type: none"> • Small chlorotic flecks on leaf petioles, stems and pegs which enlarge and turn dark in color • Symptoms may be very similar or identical to early leaf spot and can only be differentiated by examination of conidia under a microscope • However, late leaf spot causes dark brown to black spots that may or may not have halos 	<ul style="list-style-type: none"> • A 2-3 years crop rotation program involving cereals • Plough groundnut crop debris into the soil after harvest • Remove any volunteer plants from the field • Plant tolerant / resistant varieties, if available 	 <p><i>Symptoms of late leaf spot on groundnut leaves</i> PC: agritech.tnau.ac.in/</p>
<p>Rust (<i>Puccinia arachidis</i>)</p>	<ul style="list-style-type: none"> • Peanut rust is highly specific to groundnuts • Disease emergence and spread is favored by warm temperatures followed by leaf wetness • Pustules (spots or blisters) can form on all aerial plant parts except flowers 	<ul style="list-style-type: none"> • Characteristic orange pustules on the underside of leaves which become covered in masses of red-brown spores • Pustules may form on pods • The pustules when mature rupture to release masses of reddish-brown spores 	<ul style="list-style-type: none"> • Allow field to fallow for at least one month between successive groundnut plantings • Adopt cereal-cereal-groundnut crop rotation • Remove any volunteer peanut plants during fallowing to reduce inoculum • Plant resistant varieties if available • Sprays of appropriate fungicides such as Bordeaux mixture can effectively control the disease 	 <p><i>Symptoms of rust on the underside of groundnut leaves</i> PC: Scot Nelson</p>

<p>Sclerotinia blight (<i>Sclerotinia minor</i>)</p>	<ul style="list-style-type: none"> • Fungus can survive for prolonged periods in the soil, even in the absence of a groundnut crop • Emergence of the disease is favored by periods of cool weather, moist soil and high humidity 	<ul style="list-style-type: none"> • Early signs of infection include the presence of small water-soaked lesions at the base of the stems which turn yellow or bleached • Leaves on infected branches turn chlorotic and then wither • Tips of infected branches wilt or flag rapidly • Fluffy white fungal growth may appear on infected tissues during periods of high humidity 	<ul style="list-style-type: none"> • Plant seeds which are coated with protectants • Avoid injuring plants with tools and/or machinery • Application of appropriate fungicides can reduce crop losses when disease is present • Avoid excessive irrigation during cool weather 	 <p>Early infection of <i>Sclerotinia minor</i> on groundnut PC: Barbara Shew</p>  <p><i>Sclerotia, stem bleaching and shredding by Sclerotinia minor on groundnut</i></p>
<p>Southern stem rot (<i>Sclerotium rolfsii</i>)</p>	<ul style="list-style-type: none"> • Pathogen has a large host range and attacks many crops including sugar beets • Disease favors dry soils which crack deeply, allowing penetration of oxygen 	<ul style="list-style-type: none"> • Lateral branches or main stem yellowing and wilting • White fungal mat developing on the stem close to the soil line • White to brown spore containing structures developing from the fungal mats 	<ul style="list-style-type: none"> • Plough crop debris deeply into soil after harvest of crop • Crop rotation of 3-4 years is effective in reducing soil inoculum in the case of severe infestations • Applications of appropriate fungicides can help suppress stem rot but care should be taken with selection as some pesticides (e.g. benomyl) are known to increase the severity of the disease 	 <p><i>White fungal mat developing on the stem close to the soil line</i> PC: Daniel J Anco</p>  <p><i>Dense white mycelial growth and brown sclerotia of S. rolfsii</i> PC: Barbara Shew</p>

<p>Botrytis blight (<i>Botrytis cinerea</i>)</p>	<ul style="list-style-type: none"> • Disease favoured by high moisture and high temperature • Plants damaged by frost or other pathogens are particularly vulnerable to attack 	<ul style="list-style-type: none"> • Stems and leaves have a water soaked appearance at first, then turn dark • Numerous spots on upper surface of leaflets • Entire plant or discrete parts may wilt and die • There is extensive growth of mold on leaves, shoots • Lesions are covered with masses of fuzzy gray or grayish-brown spores • Occasionally, leaves have light brown spots with grayish spores 	<ul style="list-style-type: none"> • Plant early maturing groundnut varieties • Application of appropriate foliar fungicides (e.g. fungicides containing benzimidazole) 	 <p><i>Symptoms of Botrytis blight on groundnut leaves</i> PC: Mark A. Marsalis</p>  <p><i>Advanced symptoms of Botrytis blight on groundnut</i> PC: Craig Ellison</p>
<p>Tomato spotted wilt virus (Tomato spotted wilt virus, TSWV) and Peanut bud necrosis (Peanut bud necrosis virus, PBNV)</p>	<ul style="list-style-type: none"> • Both viruses have an extremely wide host range • Both viruses are transmitted by thrips 	<ul style="list-style-type: none"> • Chlorotic spots or mottled patterns on leaves • Drooping leaflets during hot weather • Necrosis of terminal buds • Stunted growth • New leaflets are reduced in size and may be puckered with mosaic mottling 	<ul style="list-style-type: none"> • Use high quality seed • Use adequate plant spacing to avoid overcrowding • Provide plants with adequate irrigation and fertilization to encourage fast establishment of seedlings and growth of a close canopy which is unattractive to thrips • Intercropping groundnut with sorghum or millet can reduce disease incidence 	 <p><i>Symptoms of tomato spotted wilt virus</i></p>  <p><i>Groundnut bud necrosis disease symptoms</i> PC: Jeffrey W. Lotz</p>

<p>Stunt (Peanut stunt virus, PSV)</p>	<ul style="list-style-type: none"> • PSV is transmitted by aphids • Legumes such as white clover are the primary source of inoculum 	<ul style="list-style-type: none"> • Leaves are curled and pale yellow to green • Leaf petioles are shortened • Plants growth is severely stunted • Plants may produce very few pods if they have been infected early in the growing season 	<ul style="list-style-type: none"> • Avoid planting groundnut in close proximity to legumes such as clover • Remove any infected plants from the field to reduce inoculum 	 <p><i>Symptoms of peanut stunt virus on peanut leaves</i></p> <p><i>Symptoms on groundnut leaves</i> PC: Florida Division of Plant Industry Archive</p>
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PC: Photo Credit

3.2 INTEGRATED MANAGEMENT OF GROUNDNUT PESTS AND DISEASES

The following practices are important in either preventing or managing groundnut pests and diseases:

3.2.1 CULTURAL CONTROL

- i. A well planned, crop rotation system can ensure good yields of high quality.
 - To avoid buildup of pests and diseases, groundnut should not be grown continuously on the same field
 - Groundnuts should be grown in rotation with other crops mainly cereals such as maize, sorghum and millet
 - A rotation of three years or longer usually reduces disease burden
- ii. Practicing field hygiene by removal of plant residues and debris from the field after harvest
- iii. Growing a trap crop such as sunflower, castor bean or other available trap crops on the field borders or in a groundnut field is recommended
- iv. For pests, destroying of egg masses on trap crops and groundnut plants by hand can be done as well as encouraging larvae predation by birds by providing perches in the field
- v. Timely harvest of groundnuts can help minimize the damage by pests and reduce the risk of fungal infection and aflatoxin contamination

3.2.2 BIOLOGICAL CONTROL

- i. Applying *Trichoderma viride* at a rate of 1 kg (mixed with 50 kg farm yard manure) per hectare to the soil at the time of sowing and gypsum at peak flowering can minimize infection of groundnuts by *Aspergillus* spp. and other fungal pathogens in the field
- ii. Releasing *Trichogramma chilonis* and application of nuclear polyhedrosis virus can be used to control defoliator insect pests

3.2.3 CHEMICAL CONTROL

- i. Groundnut seed is susceptible to fungal rot in the soil
 - A fungicidal seed treatment (seed dresser) will limit this decay and increase the crop stand in the field
 - It is therefore recommended that all seed be treated with a fungicide before planting
 - Complete coating of the seed is essential and therefore use of a mechanical mixing apparatus is strongly recommended
 - Thiram (or any other fungicide that contains dimethyldithiocarbamate) is recommended for seed dressing
- ii. Where there is high infestation by pests such as aphids, whiteflies, thrips and moths, appropriate insecticides may be used such as those that contain Lambda-cyhalothrin

3.2.4 PLATING RESISTANT/TOLERANT VARIETIES

- i. Growing groundnut cultivars that are either resistant or tolerant to a particular pest or disease is recommended where such varieties are available

4. HARVESTING AND DRYING

4.1 TIMING

- It is very important to harvest groundnuts at the correct growth stage
- Although the average maturity for most groundnut varieties is estimated at 100 days, some varieties mature as early as 90 days while others take up to 130 days
- The maturity period is also influenced by climatic conditions
- Flowering in groundnut is indeterminate and therefore there is a variable proportion of mature and immature pods at the end of the crop cycle
- Determining when to harvest groundnuts is therefore important since they can be flowering even at harvest time
- A producer must scout the field on a regular basis
- Groundnuts are mature when 70-80% of the inside of the pods shells have dark markings and the kernels are plump, with colour characteristic of that variety
- If harvested too early, the seeds will shrink when drying which lowers the yield, oil content and quality of the seed
- Delays in harvesting will result in poor quality seed due to mold infection of the seeds or the pods and subsequent aflatoxin contamination

- Late harvesting also reduces yield because higher proportions of pods are left in the ground due to the pegs being weak and the pods breaking off
- If harvested late, some non-dormant varieties will begin to sprout in the field resulting in yield losses



Figure 8: Groundnut plants with flowers, pegs, several stages of young pods, and nearly mature pods
Photo Credit: Barry Tillman (A), Ethan Carter (B)

4.2 INDICATORS FOR GROUNDNUT MATURITY

- The expected maturity date for most varieties ranges from 90-130 days
- Leaf fall is not a reliable indicator of when to harvest groundnuts since the fall could be attributed to pests and diseases
- It is recommended that a few plants (3–5) should be pulled up randomly and the pods removed and shelled
- Examine the inside of the shells
- If majority of the pods (70% upwards) have dark markings inside the shell and the seeds are plump and the characteristic colour for that variety, then the groundnuts are mature and ready for harvest
- If the crop is severely defoliated as a result of disease (only one or two leaves per branch) or if sprouting has begun, the crop should be harvested regardless of maturity
- The estimated period of maturity for each variety can be used as a rough guide for when to harvest the crop



Figure 9: Mature groundnut pods ready for harvesting (A) and a mature groundnut pod with darkening of the pericarp (B)

Photo Credit: <http://www.soilcropandmore.info> (A), CameliaTWU (B)

4.3 HARVESTING METHODS

- Caution should be taken when harvesting groundnuts to avoid breaking off the pods
- Hand pulling is one of the most widely used and suitable methods of harvesting groundnuts in sandy and loam soils while ox-drawn ploughs or hoeing can be used when drought sets in at harvest time
- Damage to pods should be avoided as this can expose groundnuts to infection by molds and aflatoxin contamination
- When pods are damaged, molds will gain access and produce aflatoxins
- The situation becomes worse when drying takes place on bare ground (which should always be avoided)

4.3.1 HAND LIFTING

- Harvesting by hand only is more suitable for the bunch/erect groundnut varieties in sandy and loam soils which are well drained
- When the soil is wet and heavy or very dry, it is much more difficult to pull up the whole plant without losing pods

4.3.2 HAND LIFTING WITH A HOE OR FORK

- By using a hoe during harvesting, it is possible to lift plants out of heavy or dry soil with reduced pod loss
- Spreading/runner varieties can also be more easily lifted using a hoe or a fork
- Care should be taken not to damage the pods with the hoe as damage makes the pods susceptible to fungal infection
- A hoe fork lessens the likelihood of such damage



Figure 10: Hand pulling of groundnuts

Photo Credit: Agropedia (A), Farmbiz Africa (B)

4.4 LIFTING

- Mechanical harvesting of groundnuts can be divided in the following processes: lifting, drying in wind rows, picking and conditioning (artificial drying)
- It is important to shake the plant after lifting to remove excess soil from the pods, particularly when the soil is wet or heavy
- Soil stuck to the pods will lengthen the drying period and produce better conditions for fungal growth
- Gently shake the soil from the groundnut pods and invert the plants resulting in a windrow of inverted plants, thus exposing the pods to the sun

4.5 DRYING

- The primary objective of curing or drying is to achieve a rapid but steady drying of pods in order to avoid aflatoxin contamination
- The harvested groundnuts have a moisture content of approximately 25%
- Groundnuts with such a high moisture content tend to rot easily and it also increases the possibility of aflatoxin contamination
- It is therefore necessary that they be subjected to a conditioning or drying process as soon as possible
- Harvested plants should be staked in the field and left there for a few days to allow them to dry in the sun and air, before stripping the pods
- Approximately 6-7 days are required to dry the groundnuts to 8% moisture level before delivery to the buyer at 7% moisture content
- Inadequately dried pods are another source of aflatoxin contamination
- Since aflatoxins are becoming a major health concern, commercial farmers are advised to measure moisture content
- It is particularly important to note that if the pods are exposed to the sun for too long, the seed quality can deteriorate considerably and germination can be affected

The different methods of drying include:

- Drying in windrows
- Drying on mats



Figure 11: Drying groundnuts in windrows (A) and improper method of drying groundnut pods on the ground (B and C)

Photo Credit: Rao Rachaputi, Yashvir S. Chauhan, Graeme C. Wright, 2021 (A), Feedipedia (B), International Institute of Tropical Agriculture (C)



Figure 12: Correct way of drying groundnut pods on tarpaulin

Photo Credit: International Institute of Tropical Agriculture, IITA (A), Tom Oder (B)



5. POST-HARVEST HANDLING

5.1 THRESHING AND SHELLING

- Threshing entails the removal of groundnut pods from the vines; while shelling is the process by which the outer shell of a groundnut is broken and the kernel or seed is removed and separated
- Groundnuts are ready for picking once the pods can be removed from the stems without causing long shreds to form
- Picking should commence when the moisture content of the seeds is approximately 10% when shelling is to be done on the farm, otherwise it should be 7%
- For smallholder farmers, shelling is usually done by hand. However, hand-operated shelling machines are currently available even among smallholder farmers
- Care should be taken to prevent cracking of the kernels during shelling
- Seeds should be well dried after shelling to avoid aflatoxin contamination and other post-harvest losses including rotting and pest infestation
- The following steps are important for maximum benefit in groundnut decortication:
 - i. Separate immature pods as well as those diseased or infested with pests
 - ii. Do not shell by beating or trampling
 - iii. Either manual or motorized shelling can be used, but only if the shellers do not damage the seeds
 - iv. Remove shriveled, discolored, moldy and damaged grains from the lot, including groundnuts with damaged testa, and dispose them
 - v. Remove dust and foreign material which can provide a source of contamination

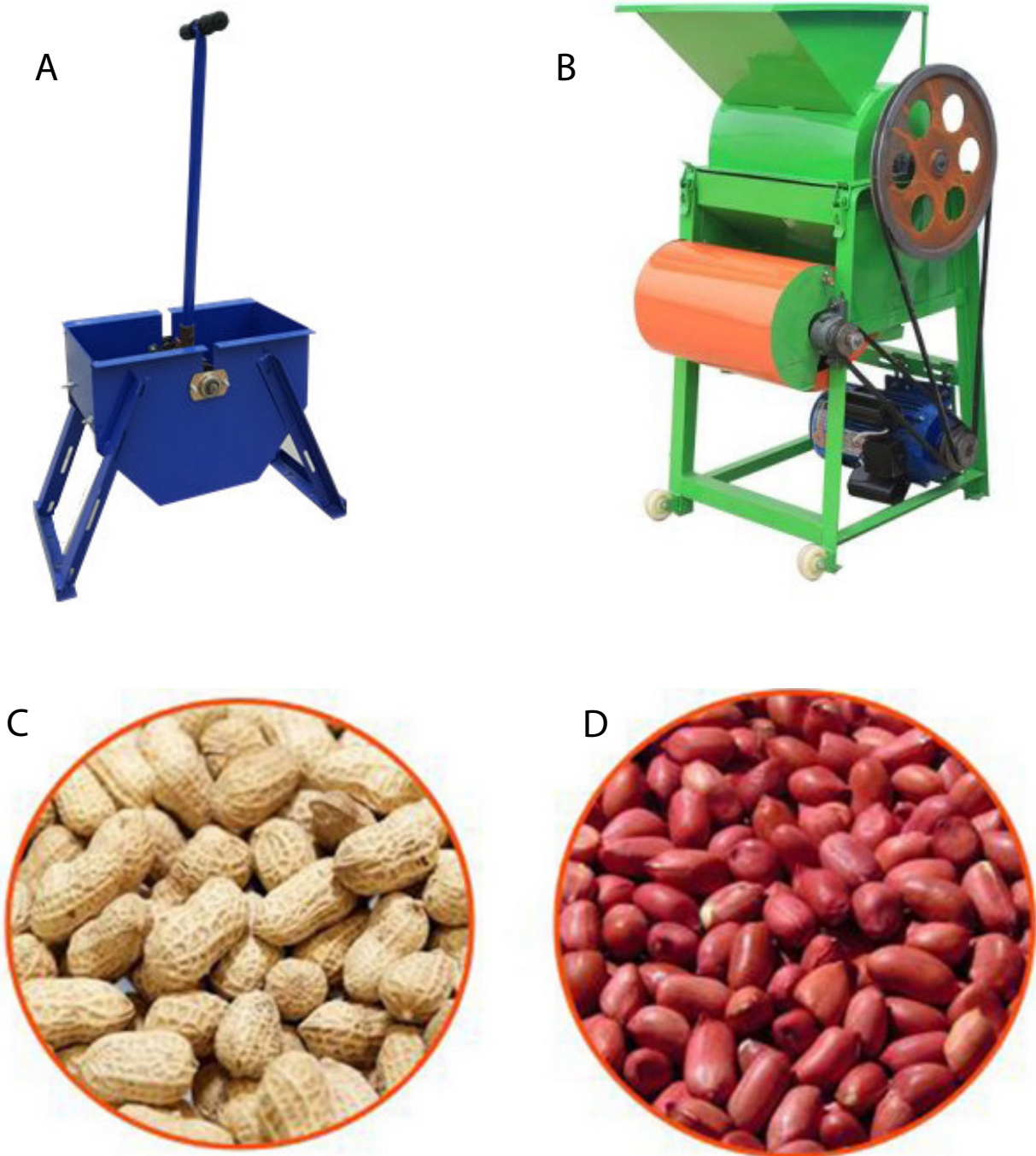


Figure 13: Manual (A) and electric (B) groundnut shellers, and groundnuts before (C) and after shelling (D)

Photo Credit: AliExpress (A, C and D), Victor Farm Machinery (B)

5.2 STRIPPING AND WINNOWING

This operation consists of separating the pods from the vegetative parts of the plants (vines). In traditional farming systems, manual stripping is common. Pods are individually detached from the vines and therefore dry very quickly stabilizing at 6-8% moisture content. The process results in a perfect quality product. This technique is used for the production of edible or confectionery

groundnuts in order to minimize pod damage and contamination by *Aspergillus flavus*. However, stripping is most often done using sticks. The sticks reduce the heap of groundnut plants into a mixture of chopped vines and partially broken pods that are then separated by winnowing.



Figure 14: Manual stripping of groundnuts (A) and winnowing shelled groundnuts to remove husks (B)
Photo Credit JK Sarojani, JS Hilli and CJ Kumar (A), International Institute of Tropical Agriculture, IITA (B)

5.3 GRADING

- Grading is important where shelling is not required before storage or transportation
- After drying, groundnut pods are graded at a prescribed moisture level in the kernels such as 7 percent
- Undersized pods, chaff, inert matter, if any, are separated
- Factors such as foreign material over 4 percent, moisture over 7 percent, damage over 1 percent, loose shelled kernel content, and split percent over 4 percent determines the value of the produce in the national and international markets
- Seed size is another important characteristic that also determines both quality and value of groundnut
- The 100-seed weight may differ among genotypes from <30 g to >150 g
- Size also varies within a genotype, and cultivars with more uniform seed size are desired for improved processing efficiency and marketing of groundnut products

5.4 PACKAGING

- Groundnuts should be packaged in a manner that will safeguard the hygienic, nutritional, technological and organoleptic qualities of the product
- The packaging should be sound, clean, dry and free from insect infestation or fungal contamination
- The packaging material should maintain a suitable environment and prevent or restrict moisture pick-up and insect/rodent infestation
- Packing should be carried out under conditions that preclude contamination of the product

- Packing materials should be made of substances that are safe and suitable for their intended use, including new clean jute bags, tinplate containers, plastic or paper boxes, or bags
- The packing material should not impart any toxic substance or undesirable odor or flavor to the product
- When the product is packaged in sacks, these must be clean, sturdy and strongly sewn or sealed
- For safe packaging, groundnuts should be dried to a moisture content of less than 10%
- Pods after grading to the requisite normal size should be packed and stored in new/clean gunny bags
- Seed are seldom shelled and packed because in the kernel (seed) form, they lose viability quickly than in-shell (pod) form
- Therefore, seed is mainly sold in the form of pods
- In several developing countries including Kenya, roasted kernels are sold loose in the market. However, packaging of the confectionery groundnut in polyethylene bags may add to the value and quality of the product in the local markets
- Other value-added products should also be sold in proper packaging to maintain moisture content and the crunchy and crispy nature of groundnuts



Figure 15: Properly packaged and stored commercial groundnut produce (A) and groundnuts packaged in a clean vacuum bag (B)

Photo Credit: India Mart

5.5 STORAGE REQUIREMENTS

To maintain good quality, the following considerations and conditions are important for storage of groundnuts:

- i. Quality raw material (well filled mature pods)
 - Clean pods that are free from visible Insect damage
 - The groundnuts should be well cured (7-8% moisture content)

- ii. It is best to store groundnuts in their shell. However, observe the following:
 - Good drying of the pods to 7–8% moisture content will help to ensure that the seeds remain in good condition during storage
 - Never bag groundnuts for storage if the pods are still damp
- iii. Sorting of groundnuts before storage
 - Deformed, damaged, shrivelled, discoloured, rotten, or moldy pods should be removed before storage
- iv. Store groundnuts in proper storage facilities
 - Treat/fumigate the storage facilities
 - The storage facility should be clean
 - The store should always be cool and dry
 - High temperature of 21-24 °C speed up respiration of grains resulting in moisture accumulation
 - The store should have good ventilation so that the pods/seeds do not increase in moisture content, which would encourage fungal growth
 - Ideally, the store should be cool, as this prolongs the storage life of the pods/ seeds
 - The store should be insect and rodent free to prevent damage to the pods/seeds and spread of fungi
 - Groundnuts should be stored raised above ground to avoid dampness
 - Bags should be stored off the floor on wooden platform (pallets) to avoid absorption of moisture from the floor
 - Bags should be made of a material which allows the air to circulate; sisal gunny bags or hermetic bags are recommended
 - Do not use polythene or polypropylene bags as these restrict air flow and promote accumulation of heat and moisture increasing the risk of fungal growth
 - For the same reason, do not cover storage bags with plastic or tarpaulin (canvas) which may also restrict ventilation and increase condensation
 - If bags are stacked, a gap should be left between stacks to allow ventilation
 - Do not stack more than ten bags high
 - Check status of the seeds regularly during storage specially for prolonged storage

Note: Moisture is the key to safe storage of groundnuts; and moisture content of grain is related to relative humidity of surrounding air. The recommended moisture content for safe storage of groundnuts is 8% and 65% relative humidity.



Figure 16: Proper storage of unshelled groundnuts in clean sacks placed on pallets in a well-ventilated store (A and B), and the recommended storage jute (C) or hermetic (D) bags.

Photo Credit: Groundnut Academy (A), Bell Industries Kenya (B and D), USAID (C)

5.6 TRANSPORTATION AND MARKETING

During transportation, a number of factors can affect the quality of groundnuts promoting mold and aflatoxin contamination. Many traders transport groundnuts for long distances using trucks which may not protect the produce from rain and dust and are usually in poor mechanical condition. Prior to transportation, traders should ensure that the produce is dried to the required moisture content. The longer groundnuts with high moisture content remain in transit, the higher the chances of mold and aflatoxin contamination. The following practices should be observed during transportation of groundnuts:

- Groundnuts should be protected from rain, rodents, insects, foreign materials and dust

- during transportation by ensuring that the produce is correctly packaged in clean bags
- Un-bagged or poorly bagged produce should not be transported to avoid spillages. Un-bagged produce easily picks up moisture and becomes moldy
- The transportation truck should be covered. Transportation of groundnuts in open trucks should be avoided
- The produce should be transported as soon as possible after harvesting
- Transportation containers should be made of material that permits thorough cleaning and fumigation
- Transporters should use clean vehicles so as not to constitute a source of contamination to the product
- Transportation trucks should be well ventilated to ensure there is no accumulation of heat and moisture resulting from respiration of the groundnuts and to prevent moisture condensation
- Transporters should use vehicles which are in good mechanical condition; vehicles in poor mechanical condition can cause delays in delivery of the produce
- The produce should be offloaded as soon as possible upon delivery. Delays in off-loading the produce increase chances of mold and aflatoxin contamination
- The produce should not be offloaded on bare ground; soil is a good source of molds and is likely to expose the groundnuts to inoculum of aflatoxin producing fungi
- To maintain good quality of produce during transportation, groundnuts should not be mixed with other products such as pesticides, charcoal, petroleum containers, animals among others



Figure 17: Improper (A) and proper (B) truck for transportation of groundnuts

Photo credit: IITA

5.6.1 LOGISTICS PROVIDERS

There are many logistics companies in Kenya that would support transportation of groundnuts and groundnut products to the desired destination. The leading global logistics companies in Kenya outlined in Table 4; while other logistics companies can be assessed on: <https://azfreight>.

[com/country-facility/freight-forwarders-in-kenya/](https://www.armstrongandassociates.com/country-facility/freight-forwarders-in-kenya/). The top 50 Global Third-Party Logistics Providers (as of September 2021) are listed in the website: <https://www.3plogistics.com/3pl-market-info-resources/3pl-market-information/aas-top-50-global-third-party-logistics-providers-3pls-list/> (Armstrong and Associates Inc).

Table 4: Examples of global logistics companies in Kenya

S/No	Company name	Web address
1	Maersk Logistics	https://www.maersk.com/local-information/africa/kenya
2	Kuehne + Nagel	www.home.kuehne-nagel.com
3	Hapag-Lloyd Container Shipping	https://www.hapag-lloyd.com/en/
4	Jansen & Heuning Bulk Handling Systems	https://www.jh.nl/en/contact/
5	DB Schenker	https://www.dbschenker.com/ke-en

5.7 GROUNDNUT PROCESSING AND VALUE ADDITION

Groundnuts are consumed in various forms including:

- i. Peanut butter
- ii. As a confectionary snack that is either roasted, salted or in sweets
- iii. Boiled groundnuts either in shell or unshelled
- iv. Groundnuts can also be crushed to produce groundnut oil



Figure 18: Various products processed from groundnuts: Roasted groundnuts with skin (A), boiled groundnuts in shell (B) roasted groundnuts without skin (C), boiled groundnuts without shell (D), peanut butter (E), and groundnut oil (F)

Photo credit: Grace Aholo (A), 24 Mantra Organics (B), Healthy Supplies (C), The Steaming Pot (D), Organic Facts (E), C. Tian (F)

5.8 HOW TO MAINTAIN GOOD QUALITY OF GROUNDNUTS AT THE FIRST COLLECTION POINT

- i. Test for aflatoxins
- ii. Determine the level of moisture content

- iii. Storage bags used at the first collection point should be of good quality and with the ability to prevent insect damage, and heat and moisture accumulation
- iv. Ensure the produce is stored in a well-ventilated space awaiting the next step

5.9 RECOMMENDED POST-HARVEST PRACTICES TO MINIMIZE AFLATOXIN CONTAMINATION

- Do not delay harvest when groundnuts have reached maturity
- Avoid field drying of groundnuts when attached to haulms as aflatoxin levels increase with delays of produce in the field. Immediately after harvesting, pluck the pods off the haulms and dry as soon as possible
- Harvest carefully to avoid mechanical damage, especially where hand hoes are used to harvest the pods
- Do not dry produce in contact with the soil. Use clean sheets, for example polythene sheets or tarpaulin or mats made of papyrus, cemented grounds or raised structures
- Dry harvested pods to moisture content level below 10%
- Avoid mixing diseased or infected pods with healthy ones
- Sort out immature, diseased and pest infested pods during shelling
- Do not shell by beating or trampling on groundnut. Manual or motorized shelling is recommended. Use hand or motorized shellers specifically designed for groundnuts
- Do not sprinkle water on dry pods while using mechanical shellers; instead, adjust (where possible) the space between blades and the sieve according to pod size to reduce breakage
- Remove shriveled, discolored, moldy and damaged grains from the lot including groundnuts with damaged testa and dispose them
- Remove dust and foreign material which can be a source of contamination
- Properly dry groundnuts to less than 10% moisture content for safe storage
- Place groundnuts in packages that will maintain suitable environment and prevent or restrict moisture pick-up and insect/rodent infestation
- Use new/clean gunny or polybags to store groundnuts
- Do not place bags directly on the floor during storage
- Do not heap groundnuts (whether seed or in shells/pods) on the floor/ground inside storage structure
- Store groundnuts in proper storage facilities that are cool, well-ventilated, dry and with low relative humidity of $\leq 65\%$
- Do not expose groundnuts to moisture during transportation and marketing
- Control insects and rodents during storage
- Do not mix new produce with old stock

5.10 PRINCIPLES OF QUALITY MANAGEMENT IN THE GROUNDNUT INDUSTRY

In general, the operating system of quality control in the groundnut industry must meet some specific tasks:

- i. Ensure compliance with sanitary standards and compliance requirements of the legislation, including with regard to food safety standards, the Good Manufacturing Practices (GMP) and the system Hazard Analysis and Critical Control Points (HACCP)
- ii. There is need for procedures to control insects, rodents, birds and other pests, and procedures for cleaning and sanitizing equipment, industrial plant and storage areas
- iii. Personal hygiene of staff working on process lines and proper habits on food handling should be implemented and monitored to ensure that food safety standards are met
- iv. In cooperation with the Departments of production, research and development, engineering or operations, the Department of quality control analyzes manufacturing processes to “Hazard Analysis and Critical Control Points”
- v. The integrity and safety of food products should be ensured through the identification and assessment of all unit operations of the process in order to prevent potential contamination and adulteration that could expose consumers to health risks

6. QUALITY REQUIREMENTS FOR DIFFERENT GROUNDNUT MARKETS

6.1 REQUIREMENTS FOR THE EAST AFRICA COMMUNITY MARKET

To export raw, roasted or fried groundnuts to the EAC, they should comply with the standards specified in EAS 57-1: 2000¹ (EAC, 2000), which are under revision as specified in DEAS 888: 2022² (EAC, 2022). In summary, the requirements are outlined in the following sections:

6.1.1 GENERAL REQUIREMENTS

- a. Raw groundnuts shall be whole, mature and uniform in shape, size and colour according to variety and grade
- b. Roasted/fried groundnuts shall be whole or split
- c. Roasted/fried whole groundnuts shall not be mixed with splits
- d. Roasted/fried groundnuts shall peel easily
- e. Raw, roasted and fried groundnuts shall be free from dead or living insects, insect fragments and mites

1 East African Standard Groundnuts (peanuts) – Specification Part 1: Raw groundnuts for table use and for oil milling

2 Draft East African Standard - Raw, roasted and fried groundnuts kernels - Specification

6.1.2 SPECIFIC QUALITY REQUIREMENTS

Raw, roasted and fried groundnuts shall comply with requirements outlined in Table 5.

Table 5: Specific requirements of raw, roasted and fried groundnuts for export to the East African Community market

S/N	Characteristic		Requirement	Test method
I	Moisture content (% or m/m) max.	Raw	8.0	ISO 665
		Roasted and fried	2.0	
li	Free fatty acids (% or m/m) max		2.0	ISO 729

ISO 665, Oilseeds - Determination of moisture and volatile matter content

ISO 729, Oilseeds - Determination of acidity of oils

6.1.3 GRADING REQUIREMENTS

Raw groundnuts may be classified as Grade 1, Grade 2 or Grade 3 as outlined in Table 6.

Table 6: Grading requirements of raw groundnuts for export to the East African Community market

S/N	Characteristic	Requirement			Test method
		Grade 1	Grade 2	Grade 3	
i	Damaged kernels, % by mass, max.	0.5	1.5	<3	ISO 605
ii	Other defects, % by mass, max.	0.5	1.5	<3	
iii	Split and broken kernels, % by mass, max.	1.0	2.0	3.0	
iv	Foreign matter, % by mass, max.	0.1	0.2	0.3	
<p>NOTE: The maximum total tolerance limits for Grade 1 is 2.0 %, 3.0 % for Grade 2 and 4.0 % for Grade 3 by number or weight for groundnuts corresponding to the size immediately above and/or below that indicated on the package</p>					

ISO 605, Pulses - Determination of impurities, size, foreign odours, insects, and species and variety - Test methods

6.1.4 CONTAMINANTS GUIDELINES

6.1.4.1 AFLATOXIN

Aflatoxin limits for raw, roasted and fried groundnuts shall comply with the limits specified in Table 7.

Table 7: Aflatoxin limits for raw, roasted and fried groundnuts for export to the East African Community market

S/No.	Characteristic	Limit	Test method
i	Total aflatoxin content, ppb, max.	10	ISO 16050
ii	Aflatoxin B1, ppb	5	

ISO 16050, Foodstuffs — Determination of aflatoxin B1, and the total content of aflatoxins B1, B2, G1 and G2 in cereals, nuts and derived products – High performance liquid chromatographic method

6.1.4.2 PESTICIDE RESIDUES

Raw, roasted and fried groundnuts shall conform to those maximum residue limits established by the Codex Alimentarius Commission (CAC) for this product. Where the use of certain pesticides is prohibited by some Partner States, then it should be notified to all Partner States accordingly.

6.1.4.3 OTHER CONTAMINANTS

Raw, roasted and fried groundnuts shall comply with those maximum limits for other contaminants established in CXS 193³ (Codex general standard for contaminants and toxins in foods).

6.1.5 MICROBIOLOGICAL REQUIREMENTS

Raw, roasted and fried groundnuts shall be free of pathogenic microorganisms and shall comply with the microbiological requirements specified in Table 8.

Table 8: Microbiological limits for raw, roasted and fried groundnuts

S/No.	Characteristic	Limit	Test Method
i	<i>Escherichia coli</i> , MPN/gh	Absent	ISO 16654
ii	<i>Salmonella</i> spp. per 25 g	Absent	ISO 6579-1
iii	<i>Staphylococcus aureus</i> , CFU/g	Absent	ISO 6888-1

ISO 16654, Microbiology of food and animal feeding stuffs - Horizontal method for the detection of *Escherichia coli*

ISO 6579-1, Microbiology of the food chain - Horizontal method for the detection, enumeration and serotyping of *Salmonella* - Part 1: Detection of *Salmonella* spp.

6.1.6 PACKAGING

Raw, roasted and fried groundnuts shall be packaged in food grade containers and sealed in a manner to ensure the specified safety and quality requirements specified are maintained throughout the shelf life of the product.

3 <https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&>

6.1.7 LABELLING

- a. Name of the product shall be 'raw groundnuts' or 'roasted groundnuts' or 'fried groundnuts'; and the term groundnut may be replaced with peanut.
- b. Where grading is applied, it shall be in accordance with guidelines outline in Section 6.1.3.

6.2 REQUIREMENTS FOR THE EUROPEAN UNION MARKET

All foods, including groundnuts, sold in the European Union must be safe. Additives must be approved by the European Safety Authorities and their use must be in line with the specific legislation. Limits are placed on levels of harmful contaminants such as pesticide residues and mycotoxins. It should also be clear from the labelling that groundnuts can cause allergies.

6.2.1 BORDER CONTROL

If specific products originating from particular countries are repeatedly in violation of the applicable regulations, stricter conditions may be imposed on the import of those products, such as having to be accompanied by a health certificate and analytical test report. Products from countries that have repeatedly breached the regulations are put on a list included in the Annex of Regulation (EC) 669/2009⁴.

6.2.2 CONTAMINANTS CONTROL

The European Commission Regulation⁵ sets maximum levels for certain contaminants in food products. This regulation is frequently updated and apart from the limits set for general foodstuffs, a number of specific limits apply for contaminants in specific products including groundnuts. The most common requirements regarding contaminants in groundnuts relate to the presence and levels of mycotoxins, pesticide residues, micro-organisms, and heavy metals.

6.2.2.1 MYCOTOXINS

- The presence of mycotoxins (aflatoxins, in particular) is the main reason why groundnuts may be banned on the European market
- In 2018, the Rapid Alert System for Food and Feed (RASFF)⁶ recorded 181 border rejections of groundnuts due to higher than acceptable levels of aflatoxin content
- The level of aflatoxin B1 in groundnuts intended for direct human consumption must not exceed 2 µg/kg and the total aflatoxin content (B1, B2, G1 and G2) must not exceed 4 µg/kg
- It is therefore important to ensure you have options at your disposal for quick aflatoxin testing to assess the level of aflatoxins in each phase of the production process
- However, a higher aflatoxin content for groundnuts is allowed if the products are not intended for direct human consumption

4 <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009R0669>

5 <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32006R1881>

6 https://food.ec.europa.eu/safety/rasff-food-and-feed-safety-alerts_en

- In such cases, the groundnuts must be sorted or treated before they are placed on the market

6.2.2.2 PESTICIDE RESIDUES

- The European Union has set maximum residue levels (MRLs) for pesticides found in and on food products
- Products containing a higher concentration of pesticide residues than allowed are withdrawn from the European market
- However, it is fairly uncommon to encounter excessive levels of pesticide residues in the groundnut trade
- This is because the shell, in which residues may accumulate, is usually removed before consumption
- The European Union regularly publishes a list of pesticides⁷ which are approved for use in the European Union. This list is updated frequently

6.2.2.3 MICROBIAL CONTAMINANTS

The presence of even very low levels of *Salmonella* and *Escherichia coli* in ready-to-eat or processed foods, including groundnuts, is an important cause of foodborne illness. Groundnut processors should consider *Salmonella* and *Escherichia coli* as major public health risks in their hazard analysis of critical control points (HACCP). To avoid microbial contamination of groundnuts, it is important to follow the Codex Alimentarius Code of Hygienic Practice for Groundnuts⁸. It is important for the pods to be dried as rapidly as possible prior to storage. The moisture content must also be kept low during transportation and storage

6.2.3 ADDITIONAL REQUIREMENTS BY GROUNDNUT BUYERS IN THE EU

6.2.3.1 QUALITY REQUIREMENTS

- The quality of groundnuts is determined by the percentage of defective product by weight
- For in-shell groundnuts, defects can include empty pods, damaged pods and discoloured pods
- For groundnut kernels, defects can include damaged kernels, discoloured kernels and broken or split kernels
- The most important criteria used to define the quality of groundnuts are:
 - Grading** – The EU does not have an official standard for grading groundnuts. The most frequently used grading classification is from the United States of America. In this standard, grades are defined by the number of groundnuts counted in one ounce⁹ (e.g. 38/42 or 40/50). The size is added to the name of the groundnut type or variety (e.g. super jumbo Virginia in shell 9/11). However, grading classifications originating from other producing countries may be used, as well.

7 <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex:32011R0540>

8 Code of Hygienic Practice for Groundnuts (Peanuts), Cac/Rcp 22-1979

9 1 ounce = 28.3495g

- ii. **Type (variety)** – There are hundreds of varieties of groundnuts. The most frequently cultivated botanical groups are Runner, Spanish and Virginia (large kernel type typically found in gourmet snacks)
- iii. **Form** – The most common forms are in-shell, red skin, blanched, splits and blanched splits

6.2.3.2 FOOD SAFETY CERTIFICATION

Although food safety certification is not obligatory under European legislation, it has become a must for almost all European food importers. Most established European importers will not work with you if you cannot provide some type of food safety certification. The majority of European buyers request for certification recognized by the Global Food Safety Initiative (GFSI). For groundnuts, the most popular certification programs, all of which are recognized by GFSI, are:

- i. International Featured Standards (IFS)¹⁰
- ii. British Retail Consortium Global Standards (BRCGS)¹¹
- iii. Food Safety System Certification (FSSC 22000)¹²
 - This list is not exhaustive and food certification systems are constantly under development
 - Although different food safety certification systems are based on similar principles, some buyers may prefer one management system, in particular
 - For example, British buyers often require BRC, while IFS is more common for German retailers
 - It should be noted that food safety certification is only a basis from which to start exporting to Europe
 - Serious buyers will usually visit and audit your production facilities before doing business with you

6.2.3.3 CORPORATE SOCIAL RESPONSIBILITY

Companies have different requirements as regards social responsibility. Some companies will require adherence to their code of conduct or to common standards such as the Supplier Ethical Data Exchange (SEDEX¹³), Ethical Trading Initiative (ETI¹⁴) or Business Social Compliance Initiative code of conduct (BSCI¹⁵).

6.2.3.4 PACKAGING REQUIREMENTS

Where groundnuts are packaged for the retail market, they should be packaged in clean food

10 <https://www.ifs-certification.com/index.php/en/>

11 <https://www.brcgs.com/>

12 <https://www.fssc22000.com/?lang=en>

13 <https://www.standardsmap.org/>

<https://www.standardsmap.org/?standards=264&shortlist=264&product=Any&origin=Any&market=Any&cbi=>

14 <https://www.ethicaltrade.org/ab/out-eti>

15 <https://blog.ecratum.com/business-social-compliance-initiative-bsci>

grade containers such as glass or plastic jars, or arc-welded tins or aluminium packaging¹⁶. The packages should be properly sealed in a manner to protect the product from contamination and ensure safety and quality requirements are maintained throughout the shelf life of the product. The packaging materials and packaging process shall not contaminate the product or otherwise affect its technological, nutritional or sensory quality. A key consideration during packaging should be avoiding exposure of the groundnuts to aflatoxin producing fungi.

There are various suppliers of food grade packaging containers in Kenya as outlined in Table 9.

Table 9: Examples of suppliers of food grade packaging containers in Kenya

S/No	Company name	Web address
1	General Plastics Limited	https://www.genplastkenya.com/
2	Milly Glass Works Limited	https://millyglass.com/
3	Propak Kenya Limited	http://www.propack-kenya.com/
4	Nampak Kenya Limited	http://www.nampak.com/products/metals/kenya
5	Flexipac Limited	http://www.flexipac.co.ke/flexipac-kenya-limited/
6	Techpak Industries Limited	https://www.techpakindustries.com/
7	Statpack Industries	https://www.statpack.co.ke/
8	Platinum Packaging	https://www.ppl.co.ke/
9	Dune Packaging Limited	https://www.dunepackaging.com/
10	Packaging Industries Limited	https://www.pil.co.ke/
11	Thermopak Kenya	https://thermopakkenya.com/
12	Blowplast Limited	https://blowplastkenya.com/
13	East Africa Packaging Industries	https://eapi.co.ke/

6.2.3.5 LABELLING REQUIREMENTS

The type of groundnuts and the name of the product must appear on the label, and either “groundnuts/peanuts” or “groundnuts/peanuts in-pod”. It is common for labels on export packaging to include the crop year, as well. Information about bulk packaging has to be indicated either on the packaging or in accompanying documents. Bulk package labelling must include the following information:

- i. Name of the product
- ii. Lot identification number
- iii. Name and address of the manufacturer, packer, distributor or importer
- iv. Storage instructions - storage and transport instructions are very important due to the high oil content and sensitivity to high levels of moisture, which can negatively influence quality if not dealt with properly

16 <https://victormatara.com/list-of-best-food-packaging-companies-in-kenya/>

The lot identification number and the name and address of the manufacturer, packer, distributor or importer may be replaced by an identification mark.

- In the case of retail packaging, product labelling must be in compliance with the EU Regulation on the provision of food information to consumers
- This regulation specifies requirements for nutrition labelling, origin labelling, allergen labelling and clear legibility (minimum font size for mandatory information)
- This regulation lists groundnuts as a product which can cause allergies or intolerances, and therefore allergen information must be clearly visible on the retail packaging

6.2.4 REQUIREMENTS FOR NICHE MARKETS IN THE EU

6.2.4.1 ORGANIC GROUNDNUTS

- European legislation dictates that if you want to market groundnuts as organic, they must be grown using organic production methods
- Growing and processing facilities must be audited by an accredited certifier before you are allowed to use the European Union's organic logo on your products
- This also applies to the logo of the standard holder (for example, the Soil Association in the United Kingdom or Naturland in Germany)
- Importing organic products to Europe is only possible if you are in possession of an electronic certificate of inspection (e-COI)
- Each batch of organic products imported into the EU has to be accompanied by an electronic certificate of inspection as defined in Annex V of Regulation defining imports of organic products from third countries
- This electronic certificate of inspection has to be generated via the Trade Control and Expert System (TRACES¹⁷)
- More information concerning the electronic certification process can be received from the TRACES Helpdesk (sante-traces@ec.europa.eu)

6.2.4.2 Sustainability certification

- Two most commonly used sustainability certification schemes are Fair Trade and Rainforest Alliance
- Fair Trade international has developed a specific standard for nuts intended for small-scale producer organizations
- Fair Trade also defines the terms of payment and FairTrade Minimum Price for conventional and organic groundnuts
- In order to improve the sustainable production and sourcing of groundnuts, a group of primarily European companies and organizations formed the Sustainable Nuts Initiative in 2015. The main objective of this initiative is to improve the circumstances in nut-producing countries and work towards sustainable supply chains

6.2.4.3 ETHNIC CERTIFICATION

- The Islamic dietary laws (Halal) and the Jewish dietary laws (Kosher) impose specific dietary restrictions
- If you want to focus on Jewish or Islamic ethnic niche markets, you should consider implementing Halal or Kosher certification schemes

17 <https://www.digitalizetrade.org/projects/traces-trade-control-and-expert-system>

7. GUIDELINES FOR EXPORT AND IMPORT OF GROUNDNUTS

7.1 GUIDELINES FOR EXPORT OF GROUNDNUTS FROM KENYA

Export of groundnuts from Kenya is regulated by the Agriculture and Food Authority (AFA) Nuts and Oil Crops Directorate who are charged with the mandate of promoting best practices, regulate the production, processing, marketing, grading, storage, collection, transportation and warehousing of agricultural products. The guidelines for exporting groundnuts from Kenya are outlined by AFA¹⁸.

7.1.1 PRELIMINARY REGISTRATIONS, LICENSES AND CERTIFICATES

A trader intending to export groundnuts must first register with AFA NOCD who issue an export license. The license is valid for a period between 1st July to 30th June.

7.1.2 PERMITS

a. Nuts and oil produce product export declaration form levy

The export permit is issued per consignment of ground nuts; traders must be licensed, by the AFA Nuts and Oil Crops Directorate, prior to application for the permits.

b. Phytosanitary certificate (for dry produce)

A phytosanitary certificate certifies that plants and plant products are free from regulated pests and conform to other phytosanitary requirements of the importing country. Traders are required to obtain a phytosanitary certificate for each consignment, and are expected to know the market requirements of their intended export market. The certificate is issued by the Kenya Plant Health Inspectorate Service (KEPHIS).

c. Certificate of origin

The Certificate of Origin (COO) is an international trade document which certifies that, a certain product being exported is wholly manufactured, produced, processed or obtained from the exporting country. There are several options for the certificate of origin:

i. Non-preferential certificate of origin

A non-preferential certificate of origin is an export document issued by the Kenya National Chamber of Commerce and Industry (KNCCI) that confirms the country of origin of goods being exported. The AfCFTA certificate of origin is issued by the Kenya Revenue Authority (KRA), Rules of Origin Section. The KNCCI has the mandate to issue the ordinary or non-preferential Certificate of Origin to all exporters of goods originating from Kenya.

18 <http://nuts.agricultureauthority.go.ke/index.php/import-guidelines#ground-nuts>

ii. Preferential certificate of origin

COMESA certificate of origin

The COMESA certificate of origin is required for goods obtained, manufactured, produced or processed in Kenya, and are to be exported within the Common Market for Eastern and Southern Africa (COMESA) region. The certificate is issued per consignment.

AGOA certificate of origin

The African Growth & Opportunity Act (AGOA) certificate of origin is required for goods obtained, manufactured, produced or processed in Kenya, and are to be exported to a country within the AGOA trade Act. The certificate is issued per consignment.

GSP certificate of origin

The Generalised System of Preferences (GSP) certificate of origin is required for goods obtained, manufactured, produced or processed in Kenya, and are to be exported to a member state. The certificate is issued per consignment.

EAC certificate of origin

The EAC certificate of origin is required for goods obtained, manufactured, produced or processed in Kenya, and are to be exported within the East African Community (EAC) region. The certificate is issued per consignment.

EU certificate of origin

The EU certificate of origin is required for goods obtained, manufactured, produced or processed in Kenya, and are to be exported within the European community. The certificate is issued per consignment.

d. Export certificate

An export certificate is issued by AFA Horticultural Crops Directorate (HCD) to an exporter of horticultural produce (fresh fruits, vegetables, plants and flowers) as an indication that AFA HCD has cleared the consignment for export.

7.1.3 CLEARANCE

a. Procedure for export of groundnuts through the port of Mombasa

Export of groundnuts is regulated by AFA Nuts and Oil Crops Directorate. Click on the link for a step-by-step guide to the export procedure of Groundnuts through the Port of Mombasa.

7.1.4 PROCEDURES FOR A FIRST-TIME TRADER

This procedure sequentially compiles the licenses, permits and clearance steps to be fulfilled by a registered business owner exporting a consignment of ground nuts, of more than \$2000 of value, for the first time out of Kenya, via the Port of Mombasa to the EU.

7.2 GUIDELINES FOR IMPORT OF GROUNDNUTS INTO THE KENYAN MARKET

The guidelines for importing groundnuts into the Kenyan market are outlined by the Agriculture and Food Authority¹⁹. Nuts and oil crops products are regulated by AFA Nuts and Oil Crops Directorate who are charged with the mandate of promoting best practices, regulate the production, processing, marketing, grading, storage, collection, transportation and warehousing of agricultural products. Whereas the highlights of the requirements are outlined in the following sections, the detailed requirements can be accessed through the link: <http://nuts.agricultureauthority.go.ke/index.php/import-guidelines#ground-nuts>

7.2.1 PRELIMINARY REGISTRATIONS, LICENSES AND CERTIFICATES

a. Register as an importer

A trader intending to import such products must first register with AFA Nuts and Oil Crops Directorate, who issue the import license that is valid for one financial year, and an import permit issued per consignment.

b. Register with Kenya Plant Health Inspectorate Service (KEPHIS)

Fresh and dry produce is regulated by Kenya Plant Health Inspectorate Service (KEPHIS), who issue a plant import permit for each consignment of import²⁰.

7.2.2 PERMITS

i. Nuts and oil produce product import declaration form levy

The import declaration form levy is issued per consignment of nuts and oil crops products. Prior to application of the import permit, applicants are required to obtain a license from the Directorate.

ii. Plant import permit

The Plant Import Permit (PIP) is issued by Kenya Plant Health Inspectorate Service (KEPHIS) allowing the import of plant and plant materials into Kenya. It ascertains that the consignment has met the requirements outlined on the permit as per the type of species. The PIP is valid for six months from the date of issue.

19 <http://nuts.agricultureauthority.go.ke/index.php/import-guidelines#ground-nuts>

20 <https://www.kephis.org/index.php/import-export-requirements/seed-import>

iii. Import declaration form (IDF)

All importers are required to obtain an import declaration form (IDF) for each consignment prior to importation of any commodity. Before applying for the IDF, traders are advised to obtain permits/get a go ahead from the respective regulating Agencies for the consignment of import. Also, application for the IDF should be done before goods leave the country of origin.

iv. Import certificate

An import certificate is issued by AFA Horticultural Crops Directorate (HCD) to an importer of horticultural produce (fresh fruits, vegetables, plants and flowers) as an indication that AFA HCD has cleared the consignment for import.

7.2.3 PROCEDURES FOR A FIRST-TIME TRADER

Importation of groundnuts through the port of Mombasa

This procedure sequentially compiles the licenses, permits and clearance steps to be fulfilled by a registered business owner importing a consignment of groundnuts, of more than \$2000 of value, for the first time into Kenya, via the Port of Mombasa.

8. PEDAGOGICAL SKILLS, TEACHING TECHNIQUES AND DISSEMINATION CHANNELS

Pedagogy means the practice of teaching. This Section outlines the skills and approaches required to effectively deliver the content in this training manual to the trainees.

8.1 PEDAGOGICAL SKILLS

Pedagogical skills are a trainer's ability to instruct trainees and manage their training environment. In the context of this training manual, it is important to for the trainers to:

- i. Learn and understand the material content
- ii. Understand the existing knowledge and skills of the trainees
- iii. Effectively communicate with the trainees
- iv. Collaborate with fellow trainers
- v. Form their own fair and consistent guidelines

8.1.1 CHARACTERISTICS OF AN EFFECTIVE TRAINER

Effective trainers continuously practice and develop qualities that improve their understanding of learner and organizational needs including the objectives of the training. They understand that the more they exercise these qualities, the better equipped they will be to deliver training with accuracy and engagement, create an [active learning](#) atmosphere and incorporate current learning trends. Some of the characteristics of an effective trainer include:

- i. Be a good (and patient) listener**
 - This is a non-negotiable quality of a good trainer.
 - The trainer should have the ability to listen, ask the right questions, and understand the needs of the trainee.
- ii. Approach training strategically**
 - One of the most important qualities of a good trainer is their ability to keep their eye on the goal and handle limitations without compromising on the training quality.
- iii. Encourage engagement**
 - Training should be a two-way engagement rather than a one-person show.
 - For skill development to really happen, trainees need opportunities to share their ideas, answer questions and practice what they have learned.
 - The traditional “top-down” lecture style simply is not effective for achieving meaningful learning, no matter how knowledgeable the trainer is.
- iv. Be organized**
 - Well-organized lessons and materials help the trainer to remain focused on the topic at hand, instead of training in a haphazard way.
 - This prevents facilitated sessions from becoming dragged out and losing attention of the audience.
- v. Appreciate good instructional design**
 - The ability to design well-structured courses and build fit-for-purpose content is one of the frequently overlooked qualities of a good trainer.
 - A top-notch trainer will have the savvy to design courses that suit the mode of delivery (e.g. face-to-face, blended, or fully online), and create a wide variety of materials that engage and motivate all the trainees.
- vi. Have a finger on the pulse of learning trends**
 - Effective trainers keep up with current research in adult education and digital delivery and look out for opportunities to incorporate proven trends into their training.
 - While exceptional trainers need to know which trends are gaining traction, it is much more important that they have the ability to be critical about which trends they choose to incorporate.
 - However, incorporating trends just because they are trendy easily undermines the effectiveness of training.
- vii. Analyze and improve**
 - Self-improvement is one of the most impactful qualities of a good trainer.
 - Great trainers are not only focused on developing their trainees, but also developing themselves.

- You can improve your performance by taking advantage of surveys and other forms of feedback.
- Do not shy away from constructive feedback but take it as an opportunity to re-examine your methods and do better the next time around.
- Good trainers do not just improve themselves but also evaluate their training materials regularly.
- Old or irrelevant materials are phased out in favor of content that is more engaging and aligned with trainee feedback about the course.

viii. Embrace lifelong learning

- Trainers who regularly undertake their own learning are more in touch with their trainees.
- You cannot take a single course once and aim to reach your goal.
- Regular learning makes a trainer more effective in choosing content types, topics, and convenience features when planning a course.

8.1.2 PREPARING A GOOD PRESENTATION

- A good trainer should always aim to give a clear, well-structured presentation.
- You should know exactly what you want to say and the order in which you want to say it.
- Having thought about and planned a good structure will also help to alleviate any nervousness you may be feeling in the build up to your talk.
- In preparing a good presentation, the following considerations are important:

a. The venue – Location and size of the training room

- It is important to have advance information about the place where you are going to do the training.
- It can be helpful to arrange to see the venue before the training session.
- It helps to quell fear if you can visualize the training venue while you are preparing your talk.
- Establish the seating arrangements - theatre-style, with rows of seats; or round-table – in the training venue.
- Availability of equipment e.g. microphone, laptop, projector and flip chart.
- Availability of power points and if an extension lead/cable is required for any equipment you intend to use.
- Establish if the room has curtains or blinds. This is relevant if you intend to use visual aids, and so that you can ensure the correct ambiance for your presentation.
- The position of the light switches. Check if you need someone to help if you are using audio/visual equipment and need to turn off the lights.
- Likelihood of outside distractions e.g. noise from another room.
- Availability of parking facilities so you do not have a long walk carrying any equipment you might need to take.

- If this information is not available ahead of time, it will help to get there a bit early, to give you time to set up.

b. The audience

- Before preparing material for a presentation, consider your prospective audience.
- Tailor your talk to the audience and consider the following points:
 - i. The number of expected trainees
 - ii. The age range
 - iii. Gender - will the audience be predominantly male or female?
 - iv. Is it a captive audience or will they be there out of interest?
 - v. Will you be speaking in their work or leisure time?
 - vi. Do they know something about your subject already or will it be totally new to them? Is the subject part of their work?
 - vii. Are you there to inform, teach, stimulate, or provoke?
 - viii. Can you use humour and, if so, what would be considered appropriate? If you are in any doubt about this, it is probably best to avoid anything even remotely risqué.

c. Time for the training session

- There will often be no flexibility in the time of day that a presentation is made.
- However, it does affect what you can do, and how you might organize your presentation, because of the likely state of your audience:

Morning:

- The morning is the best time to speak because people are generally at their most alert.
- However, as it gets towards lunch time, the trainees begin to feel hungry and lose concentration. This is particularly true if the event has not included a coffee break.

Afternoon:

- After lunch, people often feel sleepy and lethargic.
- If you are given a slot immediately after lunch, it is a good idea to get your audience involved.
- A discussion or getting your audience moving about will work a lot better than simply presenting a lot of slides.
- A flip chart may also be a more useful tool than a laptop and projector, especially if it means you can open blinds and use natural light.
- Towards the end of the afternoon, people again tend to lose concentration as they start to worry about getting home, the traffic or evening responsibilities.

Evening or Weekend:

- Outside regular office hours, people are more likely to be present because they want to be rather than because they have to be there.
- There is a better chance of audience attention in the evening.
- However, if the presentation goes on for too long, people may have to leave before you have finished.
- People will also be less tolerant of a poor presentation because you are in their time, not their employer's.

8.2 STEPS FOR PLANNING A TRAINING MEETING

a. Communication skills

It is necessary to identify three different levels in the communication situation:

- i. What the trainer thinks (intention) - what the trainer wants to signify by the message
- ii. What is transmitted – the trainer's message
- iii. What the trainee perceives (effect) - what the trainee understands

Verbal, non-verbal and paraverbal communication

The paraverbal factors that influence the effectiveness of the message are directly linked to the way in which the trainer uses their voice. These factors include:

- i. **Volume** - The volume of the trainer's voice must be loud enough to be heard by all the listeners and to permit the message to be listened to comfortably.
- ii. **Rhythm** - This relates to word flow. During a presentation, the trainee must grasp words without needing to hear them again. This means that speaking too quickly hinders comprehension of the message.
- iii. **Tone** - The tone used to express a phrase has a strong influence on the meaning that it is given (e.g. affirmative, interrogative, aggressive, authoritarian). The intonation that is used should therefore correspond to the meaning that the trainer wishes to give to words.
- iv. **Articulation and pronunciation** - This refers to the way in which the trainer enunciate words. In order to be understood, it is necessary to articulate clearly and without exaggeration the sounds that make up the words.

The non-verbal factors that influence the effectiveness of the message include:

- i. **Looking at the audience** - Visual contact should be established with the audience rather than simply looking at them. This demonstrates that the trainer is interested in the trainees and captures and holds their attention.
- ii. **Silences** - When trainers speak in public, they often tend not to use silence as an expression. This is either because they want to say too much in too little time, or because they want to fill in this frightening vacuum.

- iii. **Gestures** - Gestures by a trainer always express something.
 - iv. **Movements** - The fact of moving, of being in motion, lends a certain dynamism to the presentation. However, it is preferable not to move constantly or to make movements that are too predictable.
- b. Training checklist**
- A checklist is a list of things that need to be done and/or evaluated.
 - Checklists are used to reduce human error by compensating for limitations found in human memory.
 - The list can be simple, such as a to-do list, or be more advanced and include other factors e.g. who is responsible for specific tasks, deadlines and supplementary descriptions.

The following elements should be included in a training checklist:

- i. A skilled and effective training program manager or leader
- ii. Assessments of learning needs for the target group
- iii. Training alignment with training objectives
- iv. Goals and metrics that show training effectiveness
- v. Relevant learning content
- vi. Creative ideas for training initiatives
- vii. Ongoing mobilization to encourage participation in training
- viii. Reinforcement of what the trainees learn

8.3 TEACHING/TRAINING METHODOLOGIES

The trainer may consider the following methodologies in training depending on the target groups. The methodologies broadly include but not be limited to:

8.3.1 FORMAL FACE TO FACE INTERACTIONS

There are different methods that can be used in training under a formal face to face setup such as during workshops, seminars and conferences. The approaches involve various modes of delivery such as presentations, lectures, exercises and group discussions.

8.3.1.1 INSTRUCTOR-LED TRAINING

This is the traditional type of training that occurs in a classroom setup, with a teacher or instructor presenting the material. This can be a highly effective method of training, especially for complex topics. A trainer can answer specific questions by trainees or direct them to further resources. It also allows for highly-skilled trainers to match the training level and style to the trainees in the room. However, instructor-led training has some drawbacks, including cost and time to implement. It can also be unnecessary for concise topics.

8.3.1.2 LECTURES

- They are important for getting big chunks of information to a large trainee population.
- Lecture-style training can be an invaluable resource for communicating required information quickly.
- Unlike under the instructor led approach, lectures are characterized by less interaction between a trainer and a trainee.

8.3.1.3 GROUP DISCUSSION AND ACTIVITIES

- For the right group of trainees, group discussions and activities can provide the perfect training option.
- It allows multiple people to train at once, in an environment that better fits their current Departments or groups.
- These discussions and activities can be instructor-led or facilitated by online prompts that are later reviewed by a supervisor.
- This type of training is best used for challenges that require a collaborative approach to complex issues.

8.3.2 HANDS-ON TRAINING

Hands-on training includes any experiential training that is focused on the individual needs of the trainee. Hands-on training can help trainees with enhancing their current skills. It is a time-intensive method of training, however, it is best used when there are enough resources available to support the costs during the program.

The trainees in the groundnut value chain should have hands on training on good agronomic practices, procedures for proper handling, processing, inventory and storage of groundnuts among others. This will be important for the actors to understand the importance of maintaining the integrity of groundnuts in the short and long term. There is therefore need to include specific laboratory and field based hands-on exercises for specific target groups.

8.3.3 INFORMAL FACE TO FACE INTERACTIONS

8.3.3.1 BARAZAS AND FARMER FIELD AND BUSINESS SCHOOLS

Some content and specific topics in this Manual will best be offered through a public meeting mainly aimed at sensitizing the general population on various aspects of groundnuts production, handling and storage. Other approaches such as farmer field schools can be used where there is need to teach specific groups such as farmers with the aim of improving their skills through observing, analysing and trying out new and innovative ideas on their own fields for better groundnut production, processing, handling and storage.

8.3.3.2 FIELD VISITS/EXPOSURE LEARNING

Field visits/exposure learning should be included in the training with a view of exposing the trainees to practical activities by groundnut producers and processors. Key aspects that are best handled under this approach include: diagnosis of groundnut pests and diseases, determination of groundnut maturity, post-harvest handling, grading, packaging and packaging materials, and storage. Observation of quality management systems such as HACCP can also be included in this form of learning. Where necessary, specific hands-on exercises should be included in this approach.

8.3.4 ELEARNING

- eLearning relies on courses, online videos and tests to deliver a training. Trainees can do their training with a smartphone or on their computers.
- It is one of the easiest types of training to roll out to larger populations, especially for people who are remote or have high-turnover rates.
- With interactive, tests, videos, activities, or even gamified components, it can also go a long way towards keeping your team engaged with the training.
- However, eLearning has its own challenges. Without a solid instructional design strategy behind it, the graphics and visuals that make eLearning fun can also make it gimmicky or quickly outdated.
- Keeping it up-to-date is also a necessary best practice.
- In addition, this approach will not be appropriate for smallholder producers and older trainees who are likely to have technological challenges.

8.3.5 COACHING OR MENTORING

- Coaching or mentoring can share similar qualities to hands-on training, but in this type of training, the focus is on the relationship between the trainee and a more experienced professional, such as their supervisor, a coach, or a veteran team member.
- The one-on-one mentoring style creates a relationship between trainees that carries far beyond training.
- It also allows the trainees to ask questions that they may not feel comfortable asking in a classroom, instructor-led training.
- This training method can be done in person or virtually, through online coaching sessions.
- For all its benefits, mentoring is costly in terms of the hours and should be used appropriately to reduce those associated costs.
- Coaching - bringing in a trained professional - can sometimes provide a more time-efficient alternative, but without the relationship building that is valuable in mentoring.

8.3.6 CASE STUDIES OR OTHER REQUIRED READING

- Some training topics are readily accessible through required readings.
- Such topics require detailed reading to understand concepts that may not be covered during the formal training due to limitation of time.
- Case studies, in particular, can provide a quick way for trainees to learn about real issues.
- Trainees can read through these at their own pace.
- Case studies are a great option for focused topics, but more complex topics will likely require more advanced types of training.

8.4 TRAINING TOOLS

To achieve an effective training, a trainer should ensure availability of required training tools and use the right approaches:

8.4.1 USE OF TEACHING AIDS

Visual aids are effective tools that trainers can use either in the classroom or the field to enhance trainee interest, comprehension, and retention of information and concepts. Visual aids help trainers establish, explain, connect, and associate ideas and concepts to make the process of learning more interesting, enjoyable, and effective. Examples of teaching aids include posters, videos and flip charts. Some of the benefits of visual aids in teaching and learning include:

- i. Helping inspire trainees to learn more effectively
- ii. Helping trainees retain information for a longer period of time
- iii. Providing an example to think about concepts
- iv. Increasing the trainee's vocabulary
- v. Helping trainees gain a proper view of topics and concepts
- vi. Providing hands on experience for trainees
- vii. Creating an atmosphere of interest
- viii. Making the process of teaching easier for trainers

8.4.1.1 VISUAL AID POSTERS AND PHOTOS

- Classroom learning can be enhanced significantly through the time-tested use of visual aid posters and photos that teach information and concepts.
- These educational posters can hang on a classroom wall, serving as a convenient point of reference for trainees and also enhance the visual appeal of the classroom.
- The posters can include photos of key agronomic practices, pests, symptoms of diseases, proper storage facilities among others
- Posters and photos are appropriate in training extension personnel and farmers.

8.4.1.2 EDUCATIONAL CHARTS

- These are another effective visual aid for learning.
- If a trainer needs to convey data and what it means to trainees, these charts are effective at helping them comprehend the information.
- With educational charts, a trainer can present information and numerical data in the form of reports, handouts, and presentations.

8.4.1.3 LEAFLETS

- A Leaflet is a small sheet of printed paper that puts across a short message clearly and concisely.
- Leaflets would be a good tool to pass specific information to farmers during or after training.
- The leaflet may containing short messages regarding key aspects of groundnut production, harvesting, drying, handling, grading, and storage among others.

8.4.1.4 FLIP CHARTS

- Flip charts are large sheets of paper, usually positioned on a tripod, to be used with thick and differently coloured marking pens.
- They are a simple tool that may seem “old school”, but they have many advantages when making presentations.
- Flip charts, like chalkboards and whiteboards, allow for a certain amount of spontaneity.
- They are appealing for drawing out concepts to enable better understanding and to get input directly from a group.

8.4.1.5 VIDEOS

- In an ever-changing world, the way we learn is always changing, impacted by new methods of teaching and learning.
- As a trainer, it therefore becomes important to find new ways to reach your trainees, ensuring that your message is delivered in a timely manner.
- Videos is one of the most useful teaching aids, particularly if your goal as a trainer is to engage with learners in a way that is easy for them to understand.
- In the context of this Manual, the trainer can use a video on proper spacing, sampling to assess maturity, shelling, grading groundnuts among others.

8.5 DISSEMINATION CHANNELS

Dissemination of information, knowledge and skills on groundnuts production, post-harvest handling, processing, transportation and marketing should aim at achieving the following broad goals: (1) increase the target groups’ motivation to use and apply the knowledge and skills; and (2) to increase the target group’s ability to use and apply the acquired knowledge and skills. The dissemination channels proposed should be the most effective for dissemination of the knowledge and skills during and after training for the various target groups. Emphasis should be laid of the target group in the choice of the dissemination channel. The channels can broadly include but not limited to:

8.5.1 PRINT DISSEMINATION CHANNELS

There is a wide range of print dissemination channels depending on the content to be shared and size of documents and preference of the audience. For example, some producers may prefer to store hard copy content e.g. fliers, posters, the main instructive manual due to limited access to technology.

8.5.2 AUDIO-VISUAL DISSEMINATION CHANNELS

The training session should make use of audio-visual tools to enhance training, for example public address, short videos, and role plays where technological gadgets are missing.

8.5.3 DIGITAL PLATFORMS

Depending on prevailing circumstances, and nature of target audience, some trainings/sessions can be delivered using virtual platforms such as zoom, Teams and Google classroom. Sessions can be recorded and shared with trainees and be supplemented with other modes of dissemination such as exposure learning.

9. TRAINING TIME TABLE

Training Schedule on Good Agricultural Practices and Post-Harvest Handling in the Groundnut Value Chain

DAY ONE			
Time	Sunday	Duration	Remarks/Facilitator
Afternoon/ Evening	Arrival of participants		Boarding of participants/UNIDO
DAY TWO			
Time	Monday	Duration	Remarks/Facilitator
8.30-9.00 am	Arrival of participants and registration	30 Minutes	Training venue & materials ready for use Facilitators/ UNIDO
9.00-9.30 am	Welcome participants, introduction and levelling expectations	30 Minutes	Lead Facilitator
9.30-9.45 am	Official opening	15 Minutes	UNIDO Representative
9.45-10.00 am	Brief on the training program and formation of working groups	15 Minutes	Lead Facilitator
10.00-10.30 am	Health Break & Group Photograph		
	Module 1: General aspects of groundnuts		
10.30-11.15 am	Status of groundnuts in Kenya: Current production, challenges and climatic requirements	45 Minutes	Facilitator
11.15-12.00 pm	Challenge of aflatoxin contamination in groundnuts	45 Minutes	Facilitator

12.00-1.00 pm	Pre-planting requirements for groundnut production: Site selection, soil requirements, land preparation and timing of planting	1 Hour	Facilitator
1.00-2.00 pm	Lunch Break		
	Module 2: Good agronomic practices in groundnut production		
2.00-3.00 pm	Good agronomic practices in groundnut production	1 Hour	Facilitator
3.00-3.30 pm	Group Work: Participants to list key considerations in selection of a groundnut production site and practical timing for planting in their respective regions/counties <i>Each group to present results - 5 minutes per group</i>	30 Minutes	Facilitator
	Module 3: Groundnut pests and diseases		
3.30-4.30 pm	Major pests of groundnut and management options	1 Hour	Facilitator
4.30-5.00 pm	Health Break		
DAY THREE			
Time	Tuesday	Duration	Remarks/Facilitator
8.30-9.00 am	Recap	30 Minutes	Participant
9.00-10.00 am	Major diseases of groundnut and management options	1 Hour	Facilitator
10.00-10.30 am	Health Break		
10.30-11.30 am	Integrated management of groundnut pests and diseases	1 Hour	Facilitator
	Module 4: Harvesting and drying of groundnuts		Facilitator

11.30-12.30 pm	Harvesting groundnuts: Timing, indicators of maturity, harvesting and drying methods	1 Hour	Facilitator
12.30-1.00 pm	Group Work: Participants to discuss and document tradition methods of determination of groundnut maturity and moisture content for safe storage <i>Each group to present results - 5 minutes per group</i>	30 Minutes	Facilitator
1.00-2.00 pm	Lunch Break		
	Module 5: Post-harvest handling of groundnuts		
2.00-2.30 pm	Threshing, shelling, stripping and winnowing	30 Minutes	Facilitator
2.30-3.15 pm	Grading, packaging and storage requirements	45 Minutes	
3.15-3.45 pm	Group Work: Sort and grade the provided groundnut samples for processing. List the key quality challenges in each of the samples <i>Each group to present results - 5 minutes per group</i>	30 Minutes	Facilitator
3.45-4.15 pm	Health Break		
4.15-5.00 pm	Transportation, processing, value addition and marketing	45 Minutes	
DAY FOUR			
Time	Wednesday	Duration	Remarks/Facilitator
8.30-9.00 am	Recap	30 Minutes	Participant

9.00-10.00 am	Strategies for reducing aflatoxin contamination of groundnuts	1 Hour	Facilitator
10.00-10.30 am	Health Break		
10.30-4.30 pm	Field visit to a groundnut production field -Focus of the visit: GAP, varieties, pests & diseases (diagnosis and symptoms), harvest & post-harvest practices	5 Hours	Facilitator/Extension Officer
1.00-2.00 pm	Lunch Break		
4.30-5.00 pm	Health Break		
DAY FIVE			
Time	Thursday	Duration	Remarks/Facilitator
8.30-9.00 am	Recap	30 Minutes	Participant
9.00-10.00 am	Highlights of a checklist for quality assurance in groundnut value chain	1 Hour	Facilitator
10.00-10.30 am	Health Break		
10.30-11.30 am	Pedagogical skills in training	1 Hour	Facilitator
11.30-12.00 pm	Techniques and tools for effective training	30 Minutes	Facilitator
12.00-12.30 pm	Open discussion: Lessons learnt from field visit; and action plan to address deficiencies in the existing practices	30 Minutes	Facilitator
12.30-1.00 pm	Training Evaluation/Feedback	30 Minutes	Lead Facilitator
1.00-2.00 pm	Lunch Break		
2.00-3.00 pm	Review of the Training Manual	1 Hour	Lead Facilitator
3.00-3.30 pm	Way Forward	30 Minutes	Lead Facilitator
3.30-4.00 pm	Issuance of certificates and workshop closure	30 Minutes	UNIDO Representative
PARTICIPANTS LEAVE AT THEIR PLEASURE			

REFERENCES

- Allen WS, Sorenson Jr. JW and Person Jr NK. Guide for Harvesting, Handling and Drying of groundnuts. Fact Sheet, Texas A&M University Agricultural Extension Service.
- Cilliers AJ. 2006. Groundnut Production: A Concise Guide. ARC Grain Crops Institute Potchefstroom. <https://tinyurl.com/y6yzwn5y>
- Janila P and Mula MG. 2015. Cultural Management Practices of Groundnut: Scaling-up of Improved Groundnut Varieties through Established Seed System in Various Cropping Systems of Smallholder Farmers in Odisha. ICRIAT, Patancheru, Telangana, India.
- Kalule DO, Monyo E, Deom MC, Ininda J and Oloka KH. 2013. Groundnut Production Guide for Uganda: Recommended Practices for Farmers. National Agricultural Research Organisation, Entebbe, Uganda.
- Kalule DO, Ugen MA, Tukamuhabwa P, Ochwo-Ssemakula M, Odong T, Adriko J, Kiconco F, Male A and Deom C. 2017. Molecular diagnostics of groundnut rosette disease agents in Uganda: Implications on epidemiology and management of groundnut rosette disease. *Journal of Plant Breeding and Crop Science* 9(5): 63-70. DOI:10.5897/JPBCS2016.0630
- Kayam G, Brand Y, Faigenboim-Doron A, Patil A, Hedvat I and Hovav R. 2017. Fine-mapping the branching habit trait in cultivated peanut by combining bulked segregant analysis and high-throughput sequencing. *Frontiers in Plant Science* 8: 467. <https://doi.org/10.3389/fpls.2017.00467>
- Klich MA. 2007. *Aspergillus flavus*: The major producer of aflatoxin. *Molecular Plant Pathology* 8(6): 713-722.
- Sarojani JK, Hilli JS and Kumar CJ. 2018. An alternative techno transfer through modified groundnut stripper - A case study of KVK, Dharwad, Karnataka State, India. *International Journal of Current Microbiology and Applied Sciences* 7(10): 2319 – 7706. <https://doi.org/10.20546/ijcmas.2018.710.125>
- Williams JH, Phillips TD, Jolly PE, Stiles JK, Jolly CM and Aggarwal D. 2004. Human aflatoxicosis in developing countries: A review of toxicology, exposure, potential health consequences, and interventions. *American Journal of Clinical Nutrition* 80(5): 1106-1122.
- Wright DL, Tillman B, Small IM, Ferrell JA and DuFault N. 2021. Management and Cultural Practices for Peanuts. University of Florida, Institute of Food and Agricultural Sciences (IFAS) Extension. <https://edis.ifas.ufl.edu/publication/AA258>



MARKUP

EU-EAC MARKET ACCESS UPGRADE PROGRAMME



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