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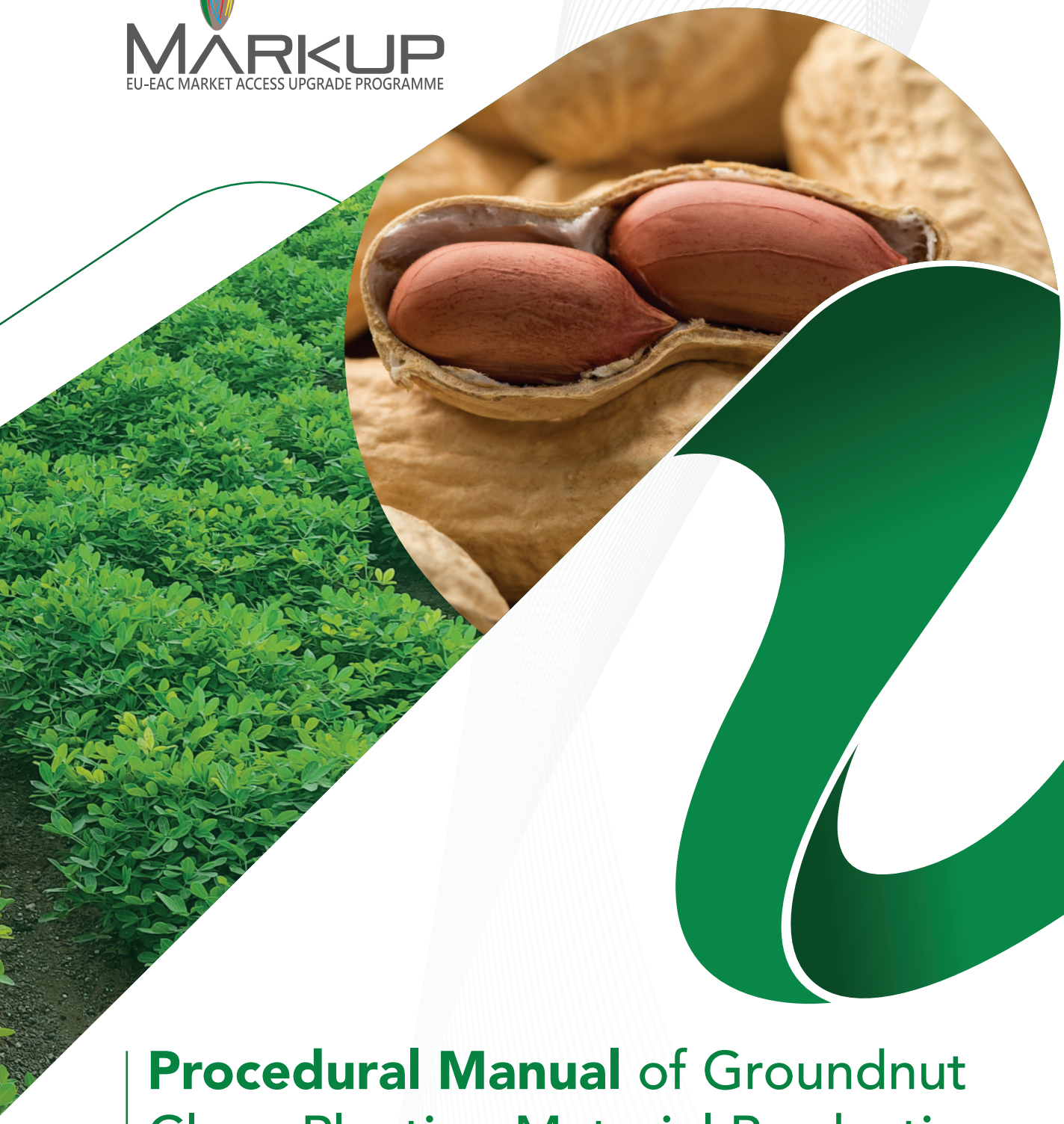

Procedural Manual of Groundnut Clean Planting Material Production

MARKUP PROJECT GROUNDNUT

Republic of Kenya
Ministry of Industrialization,Trade and Enterprise Development

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East African Community

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Groundnut Seed Manual for Production and Commercialization of Clean Planting Material

Production guide on Propagation of Clean Groundnut Planting Material

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Well managed Groundnut seed crop

Source: Nasambu Okoko, KALRO

High yielding groundnut

Source: James Mwololo, ICRISAT, KALRO - Alupe

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ACRONYMS

AEZ	Agro-ecological Zone
AFA	Agriculture Food Authority
B	Boron
Ca	Calcium
DM	Dry matter
FYM	Farm Yard Manure
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
K	Potassium
MC	Moisture content
Mg	Magnesium
NPK	Nitrogen Phosphorus and Potassium
NARS	National Agricultural Research Stations
N	Nitrogen
O	Oxygen
KALRO	Kenya Agricultural & Livestock Research Organization
KEPHIS	Kenya Plant Health Inspectorate Service
NOCD	Nuts and Oil Crops Directorate
PCPB	Pest Control Products Board
P	Phosphorus
SR	Seeding rate
Zn	Zinc

DEFINITIONS

Breeder's seed: This is seed material directly controlled by the breeder who supervises its production and provides the source for the initial and recurring increase of foundation seed.

Certified seed: Produced by selected seed growers or at seed farms under close supervision of the public or private enterprises responsible for seed multiplication and distribution, to ensure production of good quality certified seed.

Cross pollination: This is pollination of a flower or plant with pollen from another flower or plant.

Earthing up: This is mounding soil around the plant to allow pegs from higher nodes to enter the soil.

Fallow: is the minimum separation required between two or more varieties of the same species for the purpose of keeping the seed pure.

Foundation/basic seed: Progeny of breeder seed responsibility for producing foundation seed rest with the seed production agency with assistance from the breeder responsible for maintaining the purity of the variety.

Isolation distance: is the minimum separation required between two or more varieties of the same species for the purpose of keeping the seed pure.

Mono-cropping: is the agricultural practice of growing a single crop year after year on the same land in the absence of crop rotation or growing multiple crops on the same land.

Pegging: The key adaptive trait in peanut is the formation of a structure known as the peg. The peg develops after double fertilization due to elongation of intercalary meristematic cells present at the basal region of ovary. Therefore, the process of the embryo at the tip of the peg, penetrating the soil.

Phenotypic: Observable characteristics of an individual resulting from the interaction of its genotype with the environment.

Pre-basic Seed: Progeny of the breeder seed and is usually produced under the supervision of the breeder or his designated agency.

Rhizobium: Is a genus of Gram-negative soil bacteria that fix nitrogen. Rhizobium species form an endosymbiotic nitrogen-fixing association with roots of legumes and other flowering plants.

Seed dressing: This is application pesticides (fungicides/insecticides) to protect the seed and seedlings from soil pathogens particularly fungi that cause seed decay and seedling death in order to increase the plant stand in the field.

Seed Dormancy: Seed dormancy has been defined as the failure of an intact, viable seed to complete germination under favourable conditions.

Self-pollinated: This is the transfer of pollen from the anther of a flower to the stigma of the same flower.

Soil pH: This is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being a neutral pH Whereas a pH of less than 7 indicate acidity, and that one greater than 7 indicates a base (alkaline). The pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water.

ACKNOWLEDGMENTS

This work was carried out as part of the European Union funded EAC-MARKUP Programme – Kenyan window – implemented by UNIDO, which aims at creating awareness and promoting the use of clean planting material of the marketable varieties of certain crops, like mangoes, passion fruit, macadamia and ground nuts. This was based on the need, as identified by farmers/growers, for clean planting mat4rial that would ensure better yield, compliant produce and marketability. This work was primarily carried out and written by experts from the Kenyan Agriculture Research and Livestock Organization (KALRO), namely: Grace Watani (Mango), Nasambu Okoko (Groundnuts), John Ndungu (Passion Fruit) and Antony Nyaga (macadamia). The KALRO experts work under the direct supervision of Lusike Wasilwa (PhD) who coordinated and documented all their activities. The work was sanctioned by UNDO-MARKUP expert Ali Abbas Qazilbash (PhD), International Expert QI & SPS Compliance and Stefano Sedola, Chief Technical Advisor-MARKUP and facilitated by Michael 'Maina' Karuiru, National Program Coordinator of the MARKUP-Kenya project. The guide and manuals developed by the KALRO experts was used as training material for the nursery staff and extension officers at county level. The experts then imparted this knowledge at the designated counties as identified under the MARKUP project.

Special acknowledgment to the MARKUP communication team, led by Christine Misiko, (Knowledge Expert), Rachel Kibui and Brian Muriuki who used the material to develop awareness campaigns and design the communication materials and publications linked to the work carried out the experts.

In addition, the support provided by Christine 'Kiki' Mulindi in organizing the trainings and logistic support to help ensure the smooth conduct of activities linked to these activities is gratefully acknowledged.

FOREWORD

Procedural Manual for Clean Groundnut Seed Production

The European Union (EU) in partnership with the East African Community (EAC) has launched the Market Access Upgrade Programme (MARKUP) to support member countries improve market access of agro-food products to the EU and regional markets. The main purpose of this project is to contribute to the economic development of Kenya by increasing the value of both extra and intra-regional agricultural exports in selected horticulture sub sectors; (snow peas and peas, mango, passion fruit, chilies, herbs and spices, and nuts [macadamia nuts and groundnuts]). According to MARKUP, agriculture (crop and livestock production) contributes to an average of 27.3% of the national GDP and provides a source of livelihood to most Kenyans. It also contributes about 26% indirectly to GDP through linkages with other sectors such as agro-based manufacturing, transport, wholesale and retail trade. This programme (MARKUP) is structured around two intervention levels: the EAC Regional Window and the Partner States National Window with country specific projects. United Nations Industrial Development Organization (UNIDO) is the implementation partner for the Kenya-Partner States window.

MARKUP requested KALRO expertise in developing procedural manuals for the production of clean planting materials for mango, passion fruit, groundnuts and macadamia nuts. The process involved a detailed analysis of the sectors in question and identifying the various roles played by KALRO and other partners and Competent Authority (CA) bodies such as Agriculture and Food Authority (AFA) under the Nuts & Oil Crops Directorate (NOCD), Kenya Plant Health Inspectorate Service (KEPHIS), among other players. The analysis identified the strength and weaknesses of the sector and what needs attention.

A good crop stand and subsequently high yield begins with planting healthy seeds. In Kenya, the seed sector for many crops, such as cereals and legumes including groundnuts, is faced with many constraints/challenges. The major challenges include: lack of/unavailability of good quality(foundation/certified) planting materials, unreliable rainfall; lack of high yielding and disease tolerant varieties; high incidence of pests and foliar diseases (peanut rosette and leaf spot); poor agronomic practices; lack of institutional support; and poor pre-and postharvest handling techniques that result in low quality seed, poor seed quality control, poor demand estimation and inadequate distribution systems. Secondary constraints include the often long testing process before a new variety is released and registered, lack of established grades and standards.

The supply of groundnut seed to producers has been hampered by biophysical factors such as low seed multiplication rate, quick loss of seed viability, self-pollinated nature of the crop, sensitivity to heat and moisture and susceptibility to emerging pest and disease attack. In addition, costs related to marketing include bulky nature of the produce resulting in high costs of transportation and low profit margins. The above constraints make private sector actors less attracted to groundnut seeds systems, leaving the task of providing seed of improved groundnut varieties to farmers in required quantities and affordable price with the public sector seed agencies. Unfortunately, the public sector seed agencies have not been able to meet the demand for good quality seed of improved groundnut varieties in Kenya. There remains a large gap between the seed demand and seed supply, resulting in low area coverage by improved varieties. Unless enterprising and lead farmers and supportive NGOs seriously engage in seed production, this situation is likely to remain unchanged.

KALRO together with its collaborators has evaluated and identified farmer and market-preferred improved groundnut varieties, for commercial production in Kenya. Therefore, adoption of

improved groundnut varieties would significantly contribute to improving the livelihoods of resource constrained farmers. Under this project (MARKUP), a procedural manual for clean groundnut seed production has been developed. This manual describes the principles and practices in the nursery production of good quality groundnut seed planting material. It equips the seed growers, farmers and seed company managers with the knowledge and techniques of seed production, establishment of small scale-seed nurseries and commercial plots. It also provides information on groundnut seed production practices and related crop management practices. It targets both technicians and producers to ensure high quality seed production. It is designed to facilitate the learning process by incorporating practical activities that provide better and clearer understanding of the principles of seed production, establishment and management and to enable participants to transform such knowledge and skills into commercial projects.

This manual provides salient information on recommended groundnut seed production practices. Such as technical aspects of groundnut seed production: environmental requirements, sources, types/classes of seed, and field operations land preparation, varietal selection, seed management, crop protection, harvesting and postharvest, seed certification and quality control management under Kenyan conditions. The appendices contain released groundnut varieties. This is in addition to analysis of groundnut value chain in Kenya, variety and seed system and seed testing and certification forms. Costs of producing groundnut seeds per acre is included to help farmers make important decisions on investing in groundnut seed production. It is carefully written in simple language without compromising its scientific quality.

It is hoped that this manual reaches the intended users as Kenya strives towards sustainable groundnut seed production that triggers increased production and productivity and subsequently improves livelihoods for the communities served by this crop system. Given its utility, KALRO recommends that this manual be translated into Kiswahili and several vernacular languages to benefit a wider section of the groundnut farming community.

This procedural manual has been developed from extensive information from research and background data by KALRO. The design takes into consideration all the information that a seed producer and extension service provider would need to develop and produce high quality, clean groundnut seed for use by producers and extension service providers across the country and beyond. The manual is meant to be used together with the developed business plan that guides on how seed producers can operate their production units and at the same time ensuring cost effective clean planting materials.

I am greatly indebted to the KALRO commodity experts who participated in the preparation of the Procedural Manual, which is expected to epitomize a new way of operating propagation units where in addition to the technical considerations, the business aspects are also incorporated to ensure sustainability.

Lusike Wasilwa, PhD
Director Crop Systems
For Director General KALRO

1 INTRODUCTION

Groundnut is a major food and cash crop for smallholder farmers in Kenya. However, its productivity is limited by lack of/unavailability of good quality planting materials. Therefore, provision of clean improved disease and pest tolerant, high yield groundnut varieties with good market acceptability could enhance overall productivity. To maximize benefits, the adoption of improved seeds should be coupled with the use of improved crop husbandry techniques, along with enhanced opportunities to sell any marketable surpluses. This manual entails to provide seed company managers and operators with the information necessary to run the seed companies and avail high quality groundnut seeds at an affordable price.

PURPOSE OF THIS MANUAL

This manual describes the principles and practices in the nursery production of good quality groundnut seed planting material. The manual equips the seed growers, farmers and seed company managers with the knowledge and techniques of seed production, establishment of small scale-seed nurseries and commercial plots. This manual aims to provide information on groundnut seed production practices and attendant crop management practices. It targets both technicians and producers to ensure high quality seed production. It is also designed to facilitate the learning process by incorporating practical activities that provide better and clearer understanding of the principles of seed production, establishment and management and to enable participants to transform such knowledge and skills into commercial projects.

Figure 1: Mature and healthy groundnut seed
Source: Nasambu Okoko, KALRO

2 TECHNICAL ASPECTS IN GROUNDNUT SEED PRODUCTION

ENVIRONMENTAL REQUIREMENTS

Site selection:

- The environment at the site has to allow the crop to grow and reproduce
- Consider plot history, accessibility and soil type
- Avoid plots that previously hosted similar crops
- Rotate groundnuts with cereal crops for two years
- Avoid steeply sloping land since they create uneven and sometimes poor growth

Soil:

- Groundnuts grow best on friable sandy loam, sandy soils that are well drained, aerated, loosely textured soils and well supplied with calcium, potassium and phosphorous.
- The soil should also contain moderate amounts of organic matter.
- Heavier clay soils and those that tend to have surface crusting are unsuitable due to their high resistance to peg penetration and pod expansion.
- Soils that are predominantly clay also result in the loss of a large number of pods at harvest since most of them remain in the soil.
- In addition, pods harvested from clay soils tend to carry a lot of soil resulting in lengthy periods of drying which may predispose them to molding and hence aflatoxin contamination of the kernels.

Soil pH:

- Groundnut grows best in slightly acidic soils with a pH of 6.0 to 6.5 but a range of 5.5 to 7.0 is acceptable.
- Saline soils are not suitable since groundnut has a very low salt tolerance.

Moisture Requirement:

- Groundnut seed has a high demand for water during germination.
- For good germination, optimum soil moisture is required to facilitate the 35 - 40% water intake by imbibing seeds.
- Plant seeds after receiving more than 25mm of rains that is when moisture levels are favourable for rapid germination and growth.
- Rapid germination and vigorous growth help the young plant to counteract diseases.

Climate:

- Groundnuts are adapted to a wide range of climatic conditions

Temperature:

- Groundnuts grows well under optimum temperature of 27-30° C (degrees celsius) for seed germination and 24-27° C for reproductive growth.
- However, dry weather is required for maturing and harvesting.

Rainfall:

- An annual average evenly distributed rainfall of between 450 mm and 1,250 mm of evenly distributed rainfall is required annually for good growth and yield.
- Early maturing small seeded varieties require 300 - 500 mm
- While medium to late maturing large seeded varieties need 1,000 – 1,200 mm rainfall.
- Groundnuts are best grown where the rainfall is reliable and/or where access to irrigation is available.

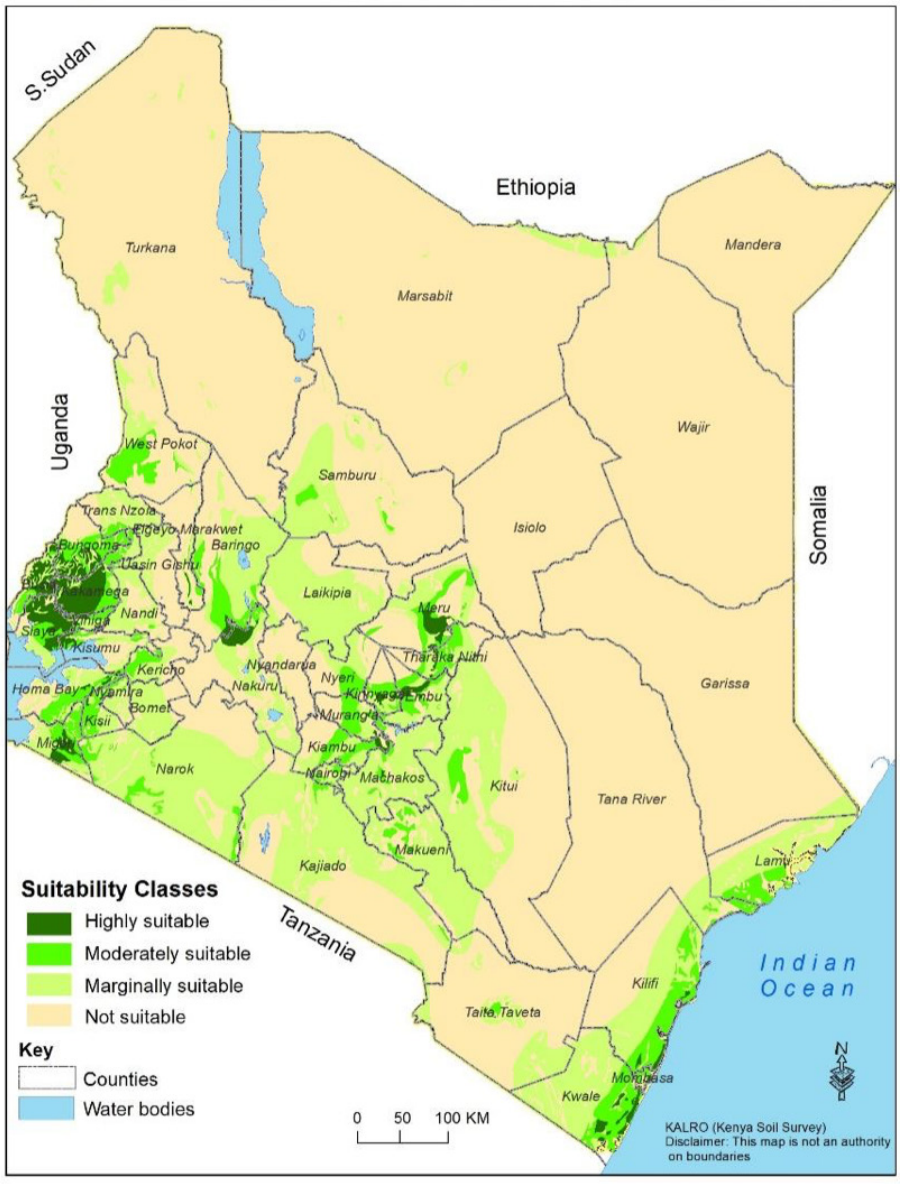


Figure 2: Land suitability for rain-fed groundnuts growing in Kenya

Source: Kenya Soil Survey, KALRO

CULTIVARS

The class of parental seed will depend on the class of seed one has opted to produce.

Source of Seed:

- The parental seed should be obtained from authorized sources. These include research institutions (KALRO, Egerton University, Leldet and ICRISAT). The seed procured for sowing should be handled carefully and stored in a cool dry place.
- Seed production follows a generation system to ensure that all seed that is marketed to farmers originates from a known source (breeder seed).
- When a variety is officially released, the small amount of breeder seed received from the breeder is multiplied through a number of generation before it becomes available to the farmers in larger quantities as certified seed.

Figure 3: Groundnut variety seed demonstration in KALRO-Kakamega
Source: Nasambu Okoko, KALRO

Maintenance and Seed Production

- The stock is referred to as parental material and forms the basis of any future maintenance and seed multiplication of the variety.
- Managed through three stages of seed multiplication: breeder's seed, foundation/basic seed, and certified seed.
- The aim is to ensure continuity of quality from the breeder to the farmers

Figure 4: A healthy crop of groundnut in Lambwe Valley
Source: Nasambu Okoko, KALRO

Production planning

- New improved varieties developed by National Agriculture Research Systems (NARS) should be multiplied and made available to farmers in the shortest possible time to realize the benefits of investments in agricultural research.
- The rate at which the variety is multiplied and accessed restricts the availability of seed and its adoption.

PRODUCTION ARRANGEMENTS

- Generally, early generations (breeder and pre-basic seed) are produced on agricultural research farms and basic seed on specialized farms.
- Certified seed is more conveniently and economically produced by farmers who are contracted by the seed enterprise.

Maintenance and seed production of groundnuts

- The certification standards are established carefully for these seed categories to help guide control during multiplication

Breeder seed

- Propagating material directly controlled by the breeder or whose production is personally supervised by a breeder provides the source for the initial and recurring increase of foundation seed
- The breeder has strict control, observes isolation distance, inspects the crop and rogues off-types regularly to maintain genetic purity
- Produced under bulk planting, but usually in small plots to allow for maximum expression and rouging
- The responsibility for maintaining the purity of breeder seed as long as the variety is in production rest with the breeder.

Pre-basic

- Progeny of the breeder seed and is usually produced under the supervision of the breeder or his designated agency.
- Commonly used for crops that have low multiplication ratio and where large quantity of certified seeds is required.

Foundation/basic seed

- Progeny of breeder seed responsibility for producing foundation seed rest with the seed production agency with assistance from the breeder responsible for maintaining the purity of the variety.
- Ensure maintenance of genetic and morphological purity through careful supervision.

Certified seed

- This is the last stage in the seed multiplication process and is produced from foundation seed.
- Produced by selected seed growers or at seed farms under close supervision of the public or private enterprises responsible for seed multiplication and distribution, to ensure production of good quality certified seed
- The certified seed should be properly processed and, treated with insecticides and fungicides before it is sold to farmers
- Farmers or growers who wish to produce certified seed must apply to the certification agency in their country
- Seed crops are inspected while growing in the field for compliance with standards for genetic purity and isolation

Common to all seed classes

- Seed harvesting, storage and conditioning must be done in a manner to prevent contamination and insure varietal purity
- Samples of the seed are laboratory tested for physical, genetic and viability quality
- After all requirements are met, certification labels are printed for seed containers or made available to accompany bulk lots

Other considerations in planning seed production

- Reserve stocks
- Choice of seed multiplication field
- Determination of quantity to be produced

Reserve stocks

- Seed to guard against losses from crop failures
- The reserve stock help to ensure continuity
- Sufficient reserve seed from the progenitors of breeder's seed, and foundation seed should be kept under cold storage conditions for at least two generations
- For certified seed, any surpluses can be stored for up to a year, under proper conditions

SITE SELECTION FOR SEED MULTIPLICATION-FIELDS

- Maintenance of a seed variety and production of its foundation seed should be grown in the recommended agro-ecological zone (AEZ) i.e. its area of adaptation.
- Rapid shifts in the genetic make-up and phenotypic characteristics of seed varieties may occur if they are multiplied in areas outside their adaptation
- The maintenance and seed production of different seed categories in their area of adaptation and under proper management also helps produce greater quantities of high quality seed

Seed selection

- Purchase certified seeds of adapted varieties from a reliable source such as NARS.
- In case of farmer saved seed, it should be pure (true to type or unadulterated), graded (medium-size), undamaged, fully developed and free from discolouration and fungal infection with a germination rate of above 90% (see Fig. 5).
- Germination tests on seeds should be carried out one week before sowing and the seed rate adjusted accordingly.
- Several other factors must be considered when deciding on a variety. These include yield, resistances to major pests and disease, grades, farmer preferences e.g. seed colour (most farmers prefer red types of kernel colour), growth habit, and maturity periods. The "perfect variety" possessing all the necessary traits for diverse environments does not exist, so it makes good sense to plant a couple of different varieties to reduce the production risk.
- Pods should be shelled 1 - 2 weeks before sowing and only good quality seed should be selected for sowing.
- It is always recommended to test the germination capacity of seed prior to planting.
- Planting two or more varieties with different maturity dates permits efficient use of limited harvesting and curing equipment.
- Purchase certified groundnut seed at regular intervals, preferably every 2 - 3 years. The seeds must be free from contamination, irrespective of the sources of supply.

Figure 5. Germination test for CG7 groundnut variety
Source: Lusike Wasilwa, KALRO

Seed dressing

- Groundnut seed is susceptible to a number of soil pathogens particularly fungi that cause seed decay and seedling death.
- Seed treatment prior to planting will protect the seed and seedlings from these pathogens and increase the plant stand in the field.
- Some of the recommended seed dressing fungicides for groundnut seed include, Mancozeb, Thiram, Marshall, Murtano etc. Confirm annually on the use of these pesticides as a seed treatment by Pest Control Products Board (PCBP).
- Complete coating of the seed is essential and the use of a mechanical mixing apparatus is strongly recommended

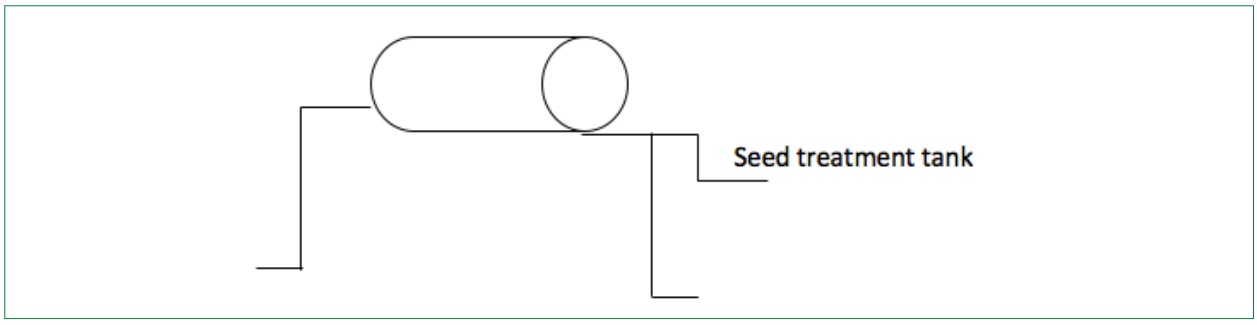


Figure 6: Seed treatment equipment
Source of drawing: Orondo Koloo, KALRO

- Instructions for the use of these pesticides are indicated on the label. While treating seeds care should be taken so as to avoid injury to seed radicles.

Dormancy:

- Seed dormancy has been defined as the failure of an intact, viable seed to complete germination under favourable conditions (Bewley, 1997).
- Dormancy allows plants to survive unfavorable environmental conditions.
- However, the period of dormancy depends on the variety, botanical group and storage conditions. Seed dormancy in groundnuts is predominant among the Virginia varieties CG 7 has a dormancy of at least 30 days. Some Virginia type groundnuts can have a dormancy of 4 or more months.
- Chemical products such as ethylene (3.5ppm) induce excellent germination. Ethephon® can also be used to break dormancy in groundnuts.
- Exposure to high temperatures (40 - 45°C for 15 days) can also break the dormancy.
- Spanish and Valencia type of groundnut has no dormancy hence their seeds easily sprouts especially if harvesting is delayed. This reduces seed yield and quality considerably.

Figure 7: Good quality of groundnut pods for seed
Source: Nasambu Okoko, KALRO

	
CG7 groundnuts	CG7 pods

Figure 8: Good quality of groundnut seed
Source: Lusike Wasilwa, KALRO

Notes

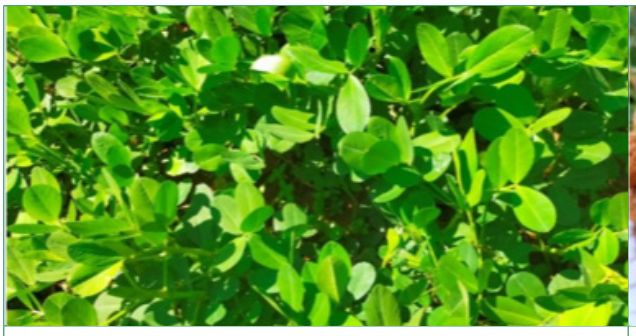
Table 1: Key attributes of adapted commercial groundnuts cultivars in Kenya

Variety/ Characteristic	ICG-SM 90704	ICGV-SM 8974 9	CG7	ICG 12991	ICG 99568
Type	Virginia / spreader	Virginia / spreader	Virginia / spreader	Spanish erect/ bunch	Spanish erect/ bunch
Foliage colour	Dark green	Dark green	Dark green	Light green	Light green
AEZ	Medium/high potential	Medium/high potential	Medium/high potential	Lower midlands	Lower midlands
Season	Long	Long	Long	Short	Short
Soil types	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Seed characters	medium , brown, dormancy	large, brown, dormancy	medium, red, dormancy	small, brown, no dormancy	medium, brown, no dormancy
Spacing	30 - 45 x 15 cm	30 - 45 x 15 cm	30 - 45 x 15 cm	30 x 10 cm	30 x 10 cm
Seed rate	40-45 kg/ac	40-45 kg/acre	40-45 kg/acre	30-35 kg/acre	30-35 kg/acre
Days to flower	40 – 45	40 – 45	40 - 45	35 – 38	35 - 38
Disease/pest/ Tolerance	Rosette virus	Rosette virus	Rosette virus	Leaf spot, aphids, & thrips	Leaf spot, aphids, & thrips
Maturity days	120-125	120-125	120-125	90-100	90-100
Yield bags/ acre	10 – 12	10 – 12	10-12	7-8	7-8
Shelling %	60-70	60-70	60-70	45- 60	45-60
Other	Rotated with cereals	Rotated with cereals	Rotated with cereals	Rotated & intercropped	Rotated & intercropped

ICGV-SM 9991

ICGV-SM 12991

ICGV-SM 12991



Well managed CG 7 groundnut crop

Dry shelled and in pods CG 7 groundnut

Figure 9:. Commercial groundnut varieties of Kenya

Source: Nasambu Okoko, KALRO

Notes

3 FIELD OPERATIONS

LAND PREPARATION

- Good land preparation is critical for maximum moisture retention, precision planting, uniform seed germination and emergence and effective weed and disease control.
- Prepare land early (two to four weeks) before the rains start, so that sowing can be done at the beginning of the rain season.
- When using a tractor plough deep, turn the soil to bury crop residue and weeds, 2 - 4 weeks before planting.
- Prepare seed beds with a smooth tilth to provide good soil-to-seed contact after sowing and harvesting.
- In wet, low lying areas, prepare ridges for planting groundnut to prevent waterlogging, and improve weed control
- Ridges should be made at, or just before, sowing and they should be flat-topped.

Figure 10: Preparation of rows to plant groundnut seed

Source: Nasambu Okoko, KALRO

FERTILIZATION APPLICATION

- Groundnut does well in soils that are rich in organic matter.
- Fertilizer levels would depend on the results of soil tests and the productivity levels targeted for the crop. Groundnuts respond better to residual fertility than to direct fertilization.
- If a well-fertilized crop precedes groundnuts, direct fertilization may not increase the yield or quality of the groundnuts. In addition to major nutrients N, P, and K, (nitrogen, phosphorus and potassium) calcium (Ca) is a critical nutrient in producing high quality groundnut seed.
- It is important to maintain near to neutral soil pH levels (as high or low levels may create either deficiency or toxicity of micro-nutrients) and Ca to K ratios of less than 3 to 1.

- Excessive K in the podding zone interferes with Ca uptake and results in pod rot and pops (unfilled pods or wind nuts).
- Regardless of soil tests, it is advisable to apply 150 - 200 kg ha-1 Ca to small-seeded varieties and 300 - 400 kg ha-1 to large-seeded varieties at the time of peak flowering.
- The gypsum/lime (depending upon soil pH) should be applied as side placement followed by light inter-row cultivation to mix it with soil and remove weeds.
- Do not apply potassium fertilizers after the groundnuts have emerged. Foliar sprays of nutrients are generally ineffective or not economically viable, except to prevent or correct some micronutrient deficiencies.
- It is also important to monitor Mg, B, and Zn (magnesium, boron and zinc) levels closely in seed production fields. They can interfere with the availability of other nutrients and their toxicity or deficiency can affect plant growth and production.
- A soil test is advisable before recommendations are made. However, if soil test results are not available, the general fertilizer recommendation is:
    - NPK kg /ha: 25 kg of N - 50 kg of P2O5 - 100 kg of K2O
    - Farm Yard Manure (FYM) or Compost: Apply 10 - 12 t ha-1; 25 - 30 days before sowing.
    - Introducing manure in a crop rotation also helps to increase the organic matter content of the soil and improve its structure.

PLANTING

Time of planting:

- The current global weather changes make it difficult to standardize the planting date.
- However, farmers should plant seeds after receiving more than 25-30mm of rains to ensure good germination and subsequent plant growth (see Figure 5).
- Early sowing ensures vigorous growth, with better resistance to, or escape from pests and diseases
- Timely planting should take advantage of periods of higher rainfall and avoid end of season drought effects.

Inoculation:

- Source rhizobium inoculum from certified commercial companies such as Mea company limited based in Nakuru. Then apply rhizobium inoculum before sowing groundnut seeds, especially when the soil is being used for the first time.
- Inoculation with Rhizobium bacteria stimulates nodulation on the roots, thus, causing the plant to provide its own nitrogen and consequently reducing the need to apply large quantities of nitrogenous fertilizer.
- When inoculating seeds, they should first be dampened and then mixed thoroughly with Rhizobium inoculant at 168 grams / 36 kg seed.

Spacing and seed rate:

- Sow groundnut seed in rows and at the recommended spacing depending on the groundnut growth habit of the variety, botanical type, seed mass and germination rate of the seed-lot.
- It is better to add 5-10% more seed to compensate for the failure of non-viable seeds to emerge. However, certified seed of CG7 has 95% germination; 9991 (90%) and ICGV 12991 (80%) (source: KALRO, 2022).

Germinated seed of CG7	Germinated seed of ICGV 9991

Figure 11: Germinating groundnut seed to demonstrate viability

Source: Lusike Wasilwa, KALRO

- Spacing of groundnuts should be 45cm between rows and 15cm between the plants and this will give a farmer a population of 60,000 plants per acre which translates into high yield and more income
- The recommended spacing between rows is 45 cm while the recommended spacing between plants within a row is:
  - **Semi-erect types:** 10 - 15 cm (e.g. CG 7, ICG 90704, ICG 88710, ICGV 83708)
  - **Bunch types:** 7.5 - 10 cm (e.g. ICGV 12991, ICG –SM 9991)
- Row spacing can be reduced from 45 cm to 30 cm, if desired, and this will allow earlier ground cover and help prevent serious weed problems.
- Generally, 150,000 plants/ha are recommended for dry land production and 300,000 plants/ha for irrigated land. The weight of seeds required to sow one hectare is called the seeding rate (SR). This depends on the varietal characteristics, seed quality and planting density. The SR is calculated as follows:

$$SR = \frac{\text{Density (plants/ha)} \times \text{Weight of 100 seeds (g)}}{10 \times \text{seed viability (\%)} \times \text{shelling yield (\%)}}$$

- Planting groundnut plants closer together results in individual plants setting fewer pods, but over a short period of time.
- Overall, this will ensure that the pods will be of a similar age and stage of development and, therefore, make it easier to decide when to harvest (Okello et al., 2010).
- Wider spacing will produce fewer yields per unit area.
- It is important to sow groundnut seed in rows and at the right spacing as this helps to achieve the correct seed rate, reduce the incidence of rosette disease, ensures a more uniform pod maturity, better quality seed and maximizes yield.
- Sowing seeds at 5 - 6 cm depth ensures that the plant develops and produces optimally.
- Seed that germinates slowly as a result of deep planting, takes longer to emerge and a substandard plant will be produced.
- Shallow planting of seed (less than 5cm) can only be considered when enough moisture is available and the climate is moist.
- In situations where moisture is not limiting 5 cm to 6 cm is the ideal planting depth. Seeds must not be sown immediately after heavy rains since they imbibe too much water, which causes rotting. This also results in excessive soil compaction which may hinder germination.

- **Long duration varieties** (120 days and above e.g. CG 7) should only be planted with the first rains in the first season.
- **Short to medium duration varieties** can be planted in either season. Early planting generally improves yields and seed quality.

Isolation distance:

- In general, natural cross pollination in groundnut is almost absent. However, at locations where bee activity is intense, depending on the variety and season, natural cross pollination can occur.
- Therefore, it is essential to have adequate isolation distance between varieties in seed production fields to help prevent contamination with pollen from other varieties and mechanical mixtures.
- Where natural cross pollination is almost negligible, an isolation distance of 3 - 5m between varieties is required for all classes of certified seeds. Isolation distance should be determined for each location, season, and variety depending upon the extent of natural cross pollination.
- Minimum separation required between two or more varieties of the same species for the purpose of keeping seed pure
- Groundnut being a self-pollinated crop requires little isolation to produce pure seed, however 200 m is recommended
- Breeder/basic seed is 10m while certified seed is 5m.

CROP ROTATION:

Prolonged mono-cropping on the same field increases the build-up of pest and disease. A well planned, crop rotation system with crops such as maize, small grains, sorghum or millet can ensure good yields of high quality groundnut. Groundnuts can be planted with maize and beans as an intercrop.

- In order to reduce risk in the farming system, groundnuts should be grown in rotation with other crops, especially grass type crops.
- Groundnuts have been shown to improve the yield of subsequent cereal crops up to 20%. One of the best crop rotation systems is one in which a grass fallow is followed by groundnuts. Fewer diseases are also present in groundnuts following a grass crop.
- Usually groundnuts also produce a better crop on fields that have been fallowed. 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 can usually reduce disease, pest and weed problems. Because of the incidence of pests and soil-borne diseases, groundnut should not be grown after cotton, although cotton can be used in rotation after groundnut.
- Crops such as soybean, tobacco, tomatoes and certain other vegetables may cause a build-up of nematodes and soil-borne diseases and, therefore, should be avoided in rotation with groundnuts.
- Cereals, such as maize, sorghum and millet are good rotational crops, and other clean-weeded crops such as cassava, sweet potato and sunflower can also be used.
- Circumstances may force a farmer to plant groundnuts in succession in which case disease problems can be expected, especially leaf and pod diseases. This can be improved by deep ploughing which may reduce the disease problem.

Notes

WEED CONTROL

Figure 12: Weeding groundnuts

Weeding:

- Weeds cause severe damage to the groundnut crop during the first 45 days of its growth.
- Weeding at least twice during this critical period is imperative, i.e., at 20 and 50 days after sowing
- During pegging, only hand weeding should be done, to avoid damage to developing pods as shown on figure

Figure 13: Well managed clean groundnut field

- A seed production field should be weed-free as weeds not only affect productivity and other field operations but also interfere with rouging.
- Further, the presence of weed seeds in produce may disqualify it for certification.
- Weeds can significantly lower the groundnut yield by competition, interference with harvest and by harbouring pests and diseases (alternate/alternative hosts).

Figure 14: Well managed clean groundnut field.

Source: Nasambu Okoko, KALRO

- Groundnut is inherently a poor weed competitor particularly 3 - 6 weeks after sowing;
- Therefore, effective early weed control implies good control of weed throughout the growing season and this will translate into higher yields.
- A combination cultural, mechanical, physical and chemical means is the most effective approach for successful management of weeds in groundnuts.
- However, the ultimate choice depends on the species of weeds involved and the level of infestation. Generally, 2 - 3 weeding's are recommended, the first before flowering and at least one additional weeding during pegging.
- Once pegging begins, weeds should be removed by hand-pulling to avoid soil disturbance near the plant, so as not to interfere with the developing pods.

Common types of weeds in groundnut fields

Common name	Photo	Description/Control
Nut grass *(Cyperus rotundus)*		- A long-lived grass-like plant usually growing 20-50 cm tall - It produces a network of creeping underground stems with small tubers (10-25 mm long). **Control:** - Spray non-selective post emergent herbicides such as glyphosate before planting
Couch grass - (*Cynodon dactylon)*		- Couch grass is a common and invasive perennial grass with creeping under leaves stems known as rhizomes - It spreads rapidly to form dense mats of underground stems - Grows among cultivated crops competing for water, nutrients and also harboring pests and diseases. **Control:** - The main non-chemical approaches to control couch grass are deep tillage and shading/smothering crops keep the soil covered with useful plants during the growing seasons and with mulch or tree cover as far as possible during dry period - This weed can effectively controlled by non-selective herbicides
Gallant soldier *(Galinsoga parviflora)*		- It is a fast-growing annual herb with the capacity to invade agricultural and other disturbed agricultural areas - The weed is highly competitive and can spread quickly, often being the dominant species in a field. G. parviflora generates considerable economic impact on crop systems, greenhouses, gardens and nurseries. **Control:** - Hand hoeing when crop plants are 2-4 weeks old - Spray with herbicides such as isoproturon, bromoxynil

Purslane *(Portulaca oleracea)*		- Fast growing, prostrate annual weed with reddish stems and very succulent leaves. - Prefers warmed climates and lower altitudes **Control:** - Soil solarization, mulches, and early cultivation of purslane seedlings can help to control infestations - Non-selective herbicides should be applied to field plots before land preparation for planting groundnuts
Wondering Jew (*Commelina benghalensis)*		- It can be described as annual or perennial (depending on moisture conditions) fleshy, creeping broadleaved herb (10-30 cm high); stems trailing along the ground, or ascending - It is a widely distributed herbaceous weed that commonly invades agricultural sites and disturbed areas **Control:** - It is a difficult to weed to control by cultivation, because broken pieces of above and below ground stems readily take root - However, hand weeding, it is necessary to uproot all the plant from the soil to ensure effectiveness - Spray with herbicides such as Butachlor
Double thorn *(Oxygonum sinuatum)*		- This is a smartweed with three pointed nutlets and small whitish flowers **Control:** - Early weeding at seedling stage will be effective managing spread of this weed
Black Jack (*Bidens pilosa)*		- Very common fast growing arable weed - Found in open ground and, cropped land but often germinates late in the season in maize crops - Does not like crop competition and shade **Control:** - Early hand hoeing in cropped land - Being an annual plant it is easy to control with either contact or non-selective herbicides

Figure 15: Common types of weeds found in groundnut fields

Source: Nasambu Okoko, KALRO

Earthing:

- Many farmers practice earthing up (mounding soil around the plant) to allow pegs from higher nodes to enter the soil.
- This is an important yield limiting factor as it influences pod formation of the lower highly productive nodes, and promote growth of the stem rot causing fungus *(Sclerotium rolfsii).* It also deteriorates the quality of earlier set mature pods while waiting for the later set pods to mature.
- Earthing up, especially in the early stage, has an influence on plant development leading to deformed plants with poor or no production at the lower nodes. Flowers cannot develop at the nodes, and thus no pegs or pods are formed.
- Earthing up later in the season normally does not lead to deformed plants (as in the previous instance) but does lead to lower yields.

Notes

Rogueing:

- This consists of manual removal of plants of other varieties present in the field intended for seed certification prior to field inspections by the inspectorate team. Plants that should be rouged out include off-type plants, prohibited and other noxious weeds.
- To rogue properly it is imperative to be thoroughly knowledgeable on variety identification characteristics, common diseases and pests.
- A minimum of two (preferably three) rogueing's should be carried out before harvest to remove off-type groundnut plants in the seed production field.
- At the seedling stage, weak, distorted, variegated, diseased, and out of the row alignment seedlings should be removed and destroyed.
- At the flowering stage, variants, not conforming to flower morphology, branching pattern, growth habit, and other diagnostic characteristics of the variety under seed multiplication should be removed from the field.
- Similarly, at the podding stage, based on peg morphology and other vegetative characters, the remaining off-types including late flowering plants should be removed.
- The last rouging is done on the harvested plants to remove plants with diseased pods and off-types based on pod and seed characteristics (Table 2). Depending on the degree of contamination a field can be retained or rejected for seed production.
- Fields of mother seeds should have less than one off-type in 1,000 and those of certified seeds, one in 200.
- Regular field checks allow elimination of off-types based on phenotypic characteristics of the cultivated variety.
- Field rouging maintains the genetic purity and can only be effective if checks are rigorously continued throughout all operations.

Table 2: Stages when to rogue groundnut seed fields

Growth Stage	Off-Types That Should Be Rouged Out
Seedling	Volunteer plants, perennial troublesome weeds, which are larger than the crop seedling,
Early Growth	Other varieties and off types taller than the seed crop variety
Flowering	Other varieties, off types which have different flower colour
Maturity	Other varieties, off types with different colour, height, maturity, etc.
Hand Harvest	Plants which differ in appearance from the seed crop variety

Notes

4 GROUNDNUT SEED HARVESTING AND CERTIFICATION

Figure 16: Harvesting quality groundnut seed
Source: Nasambu Okoko, KALRO

Figure 17: Harvesting groundnut seed of CG7 variety
Source: Nasambu Okoko, KALRO

Figure 18: Freshly harvested groundnuts
Source: Nasambu Okoko, KALRO

SEED CERTIFICATION AND QUALITY CONTROL

Groundnut seed inspection and certification is carried out by the government inspectorate departments. These include Nuts and Oil Crops Directorate is one of the arms of Agriculture and Food Authority (AFA), Kenya Plant Health Inspectorate Service (KEPHIS) in collaboration with Kenya Agricultural and Livestock Organization (KALRO). Their main role is:

- To maintain and make available to farmers, high quality and genetically pure seed involves
- Receipt and scrutiny of application verification of seed source, class and other requirements of the seed used for raising the seed crop
- Field inspections to verify conformity to the prescribed field standards
- It also includes supervision of post-harvest stages including processing and packaging

SEED SAMPLING AND ANALYSIS:

This includes

- Genetic purity test, seed health test, if any, in order to verify conformity to the prescribed standards; and
- Grant of certificate and certification tags, tagging and sealing

REPUBLIC OF KENYA

KENYA PLANT HEALTH INSPECTORATE SERVICE (KEPHIS)

Waiyaki Way: P.O. Box 49592 • Tel: 4440087, 4441804 • E-mail kephis@nbnet.coke • Fax: 4448940 • Nairobi
Mombasa Office: P.O. Box 80126 • Tel: (011) 316002/3 • Fax: (011) 316002 • Mombasa
Nakuru Office: P.O. Box 1679 • (037) 850105/6 • Fax: (037) 851268 • Nakuru
Kitale Office: P.O. Box 249 • (0325) 20180 / 20521 • Fax: (0325) 20180 • Kitale

FORM: SR9
[R.14(2)]

No. 11990

REQUEST FOR SAMPLING / SEALING / TESTING OF SEED FOR CERTIFICATION

Regional Manager

.....

.....

A. DETAILS OF SAMPLE (To be provided for by the Seed Merchant)

1. Name and Address of the Merchant .....
2. Name of Producer ..... Imported from ..... Country of Origin .....
   Species..... 4. Variety ..... 5. Class .....
6. Seed Lot Number..... 7. Ref No. .....
8. Seed Import Permit Number ..... (in case of import)
9. Weight of the lot ..... 10. Seed dressed with ..... Chemical
11. Date on which the seed is ready for sampling .....
12. Further remarks (e.g. noxious weeds, seed borne disease observed in the field, seed blends etc)
    .....
    .....
13. Tests required: Purity / Germination / TZ / Moisture content / Noxious weeds / Disease / Pests /
    Post control plots. (If other specify) .....
14. Premises where the seed are stored .....
15. Number of samples required .....
16. Number of copies required .....
    The cost of tests to be paid by ..... P.O. Box. .....
17. Date and Signature of the Merchant.
    Signature ..... Date. .....

B. SAMPLE (To be done by the seed Inspector)

18. Date of sampling ..... 19. Sample bag Number .....
    I certify that this sample was drawn by me in the prescribed manner.
    Signature. ..... Date. .....

C. SAMPLE RECEPTION

20. Remarks of the sample reception officer in the Seed Testing Laboratory
    .....
    .....
    Signature. ..... Date. .....

Copies to:
1. Seed Testing Laboratory
2. Technical Administration
3. Inspection office, seed processing plant
4. Sample book

5 DISEASES AND PESTS MANAGEMENT

PLANT PROTECTION:

- Diseases and insect pests affect groundnut productivity and the quality of produce (poor pod filling, low shelling outturn, small seed size, shriveled seed, seed discolouration, seed damage, low germination etc.).
- Groundnut is susceptible to a number of pests and diseases. There are a number of disease/insect pest management measures, including use of resistant cultivars, cultural, chemical and biological.
- Growing resistant/tolerant cultivars is the most economic and efficient measure. In case the level of resistance in a preferred cultivar is not high enough, other approaches should be combined to obtain better protection against diseases and insect pests.
- Recommended protection measures against major diseases and insect pests should be regularly followed during the cropping season.

Pest and Disease Management

Groundnuts are exposed to disease and pest attack that can cause deterioration of the quality of the product and lead to significant losses. Some of the most common diseases /pests and their control are shown on Table 2 and 3, respectively:

Table 3: Groundnut diseases of economic importance

Disease	Symptoms	Control
Rosette virus disease	Stunted plants Reduced leaflet size Yellow leaves showing mosaic pattern for chlorotic rosette Dark Green leaves for Green Rosette   **Plate: 1. Poor pod development due to groundnut rosette virus** *Source: Nasambu Okoko, KALRO*	- Crop rotation - Timely planting - Rogueing affected plants - Observe close spacing - Plant tolerant varieties: ICG-VSM 89749, ICG-VSM 90704, CG7

Disease	Symptoms	Control
Leaf Spot	Rough, circular, dark brown lesions on upper surface with halos around the lesions Defoliation under severe attack  **Plate: 2. Symptoms of leaf spot on groundnut leaves** *Source: Lusike Wasilwa, KALRO*  **Plate: 3. Advanced leaf spot damage of groundnut** *Source: Lusike Wasilwa, KALRO*	- Use of tolerant varieties - Crop rotation - Timely planting - Field hygiene - Seed dressing
Peanut Clump Virus	Stunted growth Mottling, mosaic and chlorotic rings on the leaves  **Plate: 4. Symptoms of peanut clump virus** *Source: http://agropedia.iitk.ac.in/content/peanut-clump*	- Rogueing and burning infected crops - Field hygiene – remove grassy weeds - Crop Rotation – avoid rotating with cereals

Disease	Symptoms	Control
Peanut Mottle Virus	Dark green irregular patches on young leaves  **Plate: 5 . Mottling of groundnut leaves (the dark green patches) cause by peanut mottle virus** *Source: https://www.daf.qld.gov.au/business-priorities/agriculture/plants/crops-pastures/broadacre-field-crops/managing-peanut-diseases/peanut-mottle-pmv*	- Use of tolerant varieties - Use certified seed - Crop rotation
Groundnut Blight	Sunken, brown lesions on the stems prevalent in wet weather Wilt on the leaves in patches in the field  **Plate: 6. The "burnt" leaves or blighting which is a characteristic symptom** *Source: Nasambu Okoko, KALRO*	- Early weeding - Field sanitation- remove disease plant debris from field - This disease is seed transmitted thus avoid damage of the nut

Disease	Symptoms	Control
Groundnut rust	Orange red spots appear on the leaves which turn dark brown and cause curling of the leaflets and defoliation Leaf necrosis   **Plate: 7. Front and back symptoms of groundnut rust** *Source: https://plantwiseplusknowledgebank.org/doi/10.1079/PWKB.20197800248*	- Crop rotation - Field sanitation – maintain field free of weeds - Plant on time - Continuously scout the field and use fungicides only when signs of the disease are observed

Table 4: Groundnut pests of economic importance

Pest	Type of Damage	Control
Aphids	Damage the plant tissue when feeding: vector of rosette disease  **Plate: 8. Aphid infestation of groundnut stem** *Source: Nasambu Okoko, KALRO*	- Use of tolerant varieties such as ICG 12991 - Crop rotation - Intercrop with pearl millet - Rogue all castor plants near groundnut field - Spray with appropriate insecticide
Thrips	Black, piercing-sucking insects, destroy tissue in the leaves, reduce photosynthetic capacity of the plant Attack severe under humid conditions - reproduce more Plants can get stunted  **Plate: 9. Scaled-up picture of a thrip and symptoms of damage on groundnut leaves** *Source: http://agropedia.iitk.ac.in/content/groundnut-thrips*	- Use of tolerant varieties - Scout the crop regularly looking for signs of thrips. Can also use sticky traps (yellow, blue or white) - Good agricultural practices – ensure that the crop is managed well - Intercrop with sorghum or maize - Crop rotation - Biopesticides – Confirm use on groundnut on Pest Control Products Board (PCPB) website - Chemical control – can use Deltamethrine – refer to PCPB website
Termites	Attacked plants wither and die  **Plate: 10 A termite mound in a groundnut field** *Source: Nasambu Okoko, KALRO*	- Avoid fields with history of termites - Use methyl bromide (e.g. gladiator) in termite mounds

Pest	Type of Damage	Control
Caterpillar	Damage the leaves while feeding  **Plate: 11. Tobacco caterpillar on groundnut leaves** *Source: https://agritech.tnau.ac.in/crop_protection/groundnut/crop_prot_crop_insect_oil_ground%20nut_5.html*	- Cultural practices such as early planting. - Grow castor as a boarder crop - Scouting – collect and destroy egg masses - Intercrop groundnut with Dolichos lab lab - Chemical control - use Endosulfan insecticide
White Grubs	Yellowing and rapid wilting of the plant  **Plate: 12. White grabs in groundnut roots** *Source: Pole Finyange, KALRO*	- Ensure that the farm yard manure is well decomposed - Use a moldboard plough to breakup and circulate the soil - Use of integrated pest management - When grubs are severe chemical control is recommended
Millipedes	Damage on young seedlings and developing pods  **Plate: 13. Millipede** *Source: Lusike Wasilwa, KALRO*	- This pest infests groundnut during pod formation affecting subsequent development - Practice good field sanitation - Cover exposed pods - Avoid planting near forests - Use of appropriate insecticide during seed treatment

Pest	Type of Damage	Control
Nematodes	Yellowing of foliage Reduced production Pod damage by appearance of small brown spots which become larger and darker  **Plate: 14. Groundnut pods damaged by nematodes** *Source: Jonathan D. Eisenback, Virginia Polytechnic Institute and State University, Bugwood.org*	- Use of systemic insecticide such as Carbon Furan

Figure 19: Appropriate gear (personal protective equipment [PPE]) for spraying groundnuts

Source: Nasambu Okoko, KALRO

Notes

6 HARVESTING

TIMELY HARVESTING:

- The timing of harvesting is very critical as it can significantly affect the yield and the quality of seeds. Premature harvesting lowers the yield, oil percent, flavour and quality of seeds.
- Delayed harvesting after physiological maturity can result in Aspergillus flavus infection and aflatoxin contamination in pods/ seeds and many pods may remain in the soil due to weakening of pegs. Non-dormant varieties will also start germinating if harvesting is delayed.
- Therefore, it is important to harvest at optimum maturity when 75% of pods are mature
- Harvesting is one of the most critical operations in groundnuts production. Weeds can make efficient harvesting impossible by interfering with digging or lifting.
- Determining when to harvest is important. Groundnut may gain 300 - 450 kg/ha and 2 - 3% in grade during the 10-day period before optimum harvest.
- Losses greater than 300 - 450 kg/ha may occur if the crop is not harvested at optimum maturity. In order to determine the best harvest date, a farmer must scout his crop on a regular basis.

POST-HARVEST HANDLING

Drying and storage

The groundnuts should be quickly and thoroughly dried' before storage

- Remove pods and dry them on a canvas for five days followed by winnowing to remove the soil on nut which has aflatoxin causing pathogen.
- Dry pods to 6-8 % MC and store in dry place
- Groundnuts are semi-perishable and are subject to quality losses during storage through
    - o insect and rodent infestation
    - o fungal development
    - o flavour changes
    - o rancidity
    - o viability loss
    - o physical changes like shrinkage, weight loss, etc.
- Storage under wet conditions will enhance the development of the fungus Aspergillus flavus, which leads to aflatoxin contamination
- Bag the groundnuts and stack them on wooden planks or poles to avoid damage from dampness from the wall and the floor.

Packaging

- Use new bags or packages to avoid contamination
- Packages/bags should be well labeled, indicating the crop, variety, weight, and year of production.

7 AFLATOXIN CONTAMINATION

PRE-HARVEST PREDISPOSITION

Use of susceptible cultivars

- End-of-season moisture stress for more than 20 days
- Growth cracks and mechanical injury to the pod.
- Insect damage to pods by termites or pod borers.
- Death caused by stem, root & pod rots at pod maturity
- Nematode damage to the pod

Figure 20: Aflatoxin on groundnut pods
Source: Lusike Wasilwa, KALRO

POST-HARVEST PREDISPOSITION

- Harvesting over-mature crop.
- Mechanical damage to the pods at harvest
- Stacking harvest with pod moisture is > 10%
- Damage to the pod by insects during storage
- Storing haulms with immature or small pods
- Wetting of stored pods by ground-moisture/roof leakage

PRE-HARVEST AFLATOXIN MANAGEMENT

- Use of resistant varieties
- Seed treatment with Dithane M-45(3g/kg)
- Optimal plant population (33 pl/ sq m)
- FYM or compost at 5-10 tons/ha
- Calcium supply (gypsum) at flowering
- Trichoderma application at 1 kg/ha
- Control termites and white grubs
- Avoid end-of-season drought with irrigation
- Remove dead plants before harvest
- Harvest the crop at right maturity

POST-HARVEST AFLATOXIN MANAGEMENT

- Dry the harvested produce for 3-5 days until the pod moisture is < 8%
- Strip the pod immediately after drying
- Avoid stacking
- Remove all immature and mechanical/insect damaged pods
- Separate the fully mature pods (raw use) from the remaining produce (oil extraction)
- Stack the pod-filled gunny bags on a wooden plank and store them in well aerated, waterproof storage
- Prevent insect damage to the pods in storage

Notes

8 ANNEXES

ANNEX 1. NEW ROSETTE AND LEAF SPOT DISEASES TOLERANT LINES RECOMMENDED FOR WESTERN KENYA

(Rachier et al., 2006)

Line	Maturity period	Pod yield potential T ha^{-1}	Recommended AEZ	Disease tolerance
ICGV-SM 89749	Late > 120 days	2.8*	UM_I - LM_1	Rosette
ICGV-SM 88710	Medium 100 - 110 days	2.6	LM_I - LM_2	Rosette
Uganda stripe	Medium 100 - 110 days	.5	LM_I - LM_2	Rosette
ICGV-SM 12991	Early 90 -100 days	1.5	LM_2 - LM_3	Leaf spot
ICGV-SM 129889	Early 90 -100 days	1.5	LM_2 - LM_3	Leaf spot

** Shelling % = 45-55% of the pod yield*

ANNEX 2. GROUNDNUT PRODUCTION AND PROCESSING COSTS/ ACRE BY FARMERS IN BUSIA, HOMABAY AND SIAYA, 2022

	Item	Cost	% of total
1	Ploughing	9000	18.1891673403
2	Harrowing	4000	8.0840743734
3	Seeds	10500	21.2206952303
4	Planting	4000	8.0840743734
5	Weeding	4000	8.0840743734
6	Harvesting	8000	16.1681487469
7	Postharvest Handling	4000	8.0840743734
8	Shelling	4000	8.0840743734
9	Bagging	480	0.9700889248
10	Transport	1500	3.0315278900
		49,480	**100**
	Average yield per acre/Kgs		**800**
	Cost per kg		**61.85**

ANNEX 3. GROUNDNUTS VALUE CHAIN IN KENYA

FARMGATE	FIRST BULKING	DESHELL	SIZE-GRADING	SORTING	WHOLE-SALE
▪ Variety important to value ▪ Uniformity of crop and variety important to value ▪ Aflatoxin a possible threat to value ▪ 50kg maize sack holds only 20kg groundnuts in shell ▪ Small quantities difficult to market Typical harvest farm-gate price of KES 7 to 10/ kg (unshelled in pails)	▪ Need to process ASAP (Aflatoxin and shriveling) ▪ Uniformity of variety and condition essential to marketing ▪ Price based on kernel quality, quantity and de-shelling cost ▪ 1 maize sack of 20kg unshelled yields c.12.5kg sound kernels with a max. value of $4.20 ($0.335/kg or KES/kg) at buyers warehouse	▪ Manual de-shelling slow, laborious and messy ▪ Hand-powered mechanical de-sheller (cost KES 30000 from local materials) - quick and effective ▪ 1 groundnuts bag (90kgs) shelled/ ungraded/ unsorted kernels - value = KES 4-5K at buyers warehouse ▪ Shelled kernels – greater transport efficiency.	▪ Manual grading not efficient ▪ Hand-powered mechanical graders (cost K4,000 from local materials) – quick and effective ▪ Grading also sorts out chaff etc. ▪ Grades kept separated ▪ Grading adds value of (c.$0.10/ kg or K6/kg)) but volume shrinkage from out-grades ▪ Out grades have some value locally	▪ Manual sorting only effective means ▪ Sorting tables made from local materials ▪ Different grades sorted separately and kept separate ▪ Sorters need training and supervision ▪ Additional premia ($0.05-/kg or Kshs/ kg) at buyers' warehouse if sorting consistent ▪ Rejects of too-small, splits, defects, traded locally	▪ The key buying point based on quality condition, consistency and quantity ▪ Prices always based on a sample and proportion of sound vs. unsound, and proportion of large, medium, or small grades ▪ Uniformity in variety and appearance essential

ANNEX 4. VARIETY AND SEED SYSTEM

- Select recommended and suitable groundnut varieties e.g. for western Kenya
- Valencia: ICGV-SM 95740 (red colour) and others
- Spanish: ICGV-SM 99568 (dark tan colour) and others
- Virginia: 90704 (dark tan colour) and others.
- Varieties are open pollinated; multiply seed of each variety in isolated plots (200 m)
- Harvest and wilt/dry in windrows for 3 -5 days
- Continue to sun dry for 1 – 2 weeks depending on weather conditions
- Pick the pods from the haulms
- Sort out the pods by removing damaged and unfilled pods
- Store planting material on pods in cool, dry and well ventilated store
- Two weeks to planting sun-dry the pods for 1 – 2 days then shell the seeds.
- Select fully mature and well filled nuts (sound fully mature undamaged kernels) for planting seeds.
- Before sowing treat seed with fungicide dust or appropriate pesticide to control seedling blights caused by soil bacteria and fungi.

ANNEX 5. SEED TESTING FOR CERTIFICATION

REPUBLIC OF KENYA

KENYA PLANT HEALTH INSPECTORATE SERVICE (KEPHIS)

Waiyaki Way: P.O. Box 49592 • Tel: 4440087, 4441804 • E-mail kephis@nbnet.coke • Fax: 4448940 • Nairobi
Mombasa Office: P.O. Box 80126 • Tel: (011) 316002/3 • Fax: (011) 316002 • Mombasa
Nakuru Office: P.O. Box 1679 • (037) 850105/6 • Fax: (037) 851268 • Nakuru
Kitale Office: P.O. Box 249 • (0325) 20180 / 20521 • Fax: (0325) 20180 • Kitale

FORM: SR9
[R.14(2)]

No. 11990

REQUEST FOR SAMPLING / SEALING / TESTING OF SEED FOR CERTIFICATION

Regional Manager

.....

.....

A. DETAILS OF SAMPLE (To be provided for by the Seed Merchant)

1. Name and Address of the Merchant .....
2. Name of Producer ..... Imported from ..... Country of Origin .....
   Species..... 4. Variety ..... 5. Class .....
6. Seed Lot Number..... 7. Ref No. .....
8. Seed Import Permit Number ..... (in case of import)
9. Weight of the lot ..... 10. Seed dressed with ..... Chemical
11. Date on which the seed is ready for sampling .....
12. Further remarks (e.g. noxious weeds, seed borne disease observed in the field, seed blends etc)
    .....
    .....
13. Tests required: Purity / Germination / TZ / Moisture content / Noxious weeds / Disease / Pests /
    Post control plots. (If other specify) .....
14. Premises where the seed are stored .....
15. Number of samples required .....
16. Number of copies required .....
    The cost of tests to be paid by ..... P.O. Box. .....
17. Date and Signature of the Merchant.
    Signature ..... Date. .....

B. SAMPLE (To be done by the seed Inspector)

18. Date of sampling ..... 19. Sample bag Number .....
    I certify that this sample was drawn by me in the prescribed manner.
    Signature. ..... Date. .....

C. SAMPLE RECEPTION

20. Remarks of the sample reception officer in the Seed Testing Laboratory
    .....
    .....
    Signature. ..... Date. .....

Copies to:
1. Seed Testing Laboratory
2. Technical Administration
3. Inspection office, seed processing plant
4. Sample book

9 REFERENCES

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4. Okello D. K., Biruma M. and Deom C. M. (2010). Overview of groundnuts research in Uganda: Past, present and future. African Journal of Biotechnology Vol. 9(39), pp. 6448-6459
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