Best Choices for Enhancing Groundnut Productivity in Nigeria

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Published by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patencheru, India.

Website: http//EXPLOREit.icrisat.org
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ISBN 978-93-86527-02-8

ICRISAT is a science-based agricultural, non-profit and apolitical international organization with headquarters at Patencheru, India. It is a member of the CGIAR - Consultative Group of International Agricultural Research. ICRISAT conducts agricultural research for development in the dry savannas of Nigeria in collaboration with several national and international partners.

Correct Citation
Vabi B.M., Mohammed S.G., Echekwu C.A., Mukhtar A.A., Ahmed B., Ajeigbe, H.A. and Eche C.O. (2019). Best Choices for Enhancing Groundnut Productivity in Nigeria. ICRISAT, Patencheru. 29 pp.
ISBN 978-93-86527-02-8

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Cover Page: Groundnut Pods and Kernels

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ACKNOWLEDGEMENTS

The authors of **Best Choices for Enhancing Groundnut Production in Nigeria** appreciate the United States Agency for International Development (USAID) and Bill and Melinda Gates Foundation (BMGF) for providing funds used in the implementation of two project in Nigeria namely *Increasing Groundnut Productivity of Small-scale Farmers in Ghana, Mali and Nigeria and Tropical Legumes (Phase III).*

The authors also recognize contributions from Dr. Babu Motagi, one time ICRISAT Groundnut Breeder based in Nigeria, Mr. Bala Lawal, Mr. Kunihya Ayuba, Engineer Adinoyi Aliyu and Mr. Hassan-Inuwa Abubakar, of ICRISAT Nigeria. Dr. Hippolyte Affognon, former Project Coordinator of the Groundnut Upscaling Project based in Bamako (Mali) played a major role while still in command. The continuous support of Project Desk Officers and selected Extension Agents of the ADPs of Kano, Kebbi, Katsina, Jigawa and Sokoto States was exceptional throughout project implementation.

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Between the 2015 and 2018 cropping seasons, the authors worked closely with several farmers and farmer groups to demonstrate the performance of improved versus most popular local groundnut varieties and different options for managing aflatoxin contamination. Private seed companies, farmer groups and the National Agricultural Seeds Council (NASC) were actively engaged in building capacities for producing, distributing and marketing of quality groundnut seeds. These provided real opportunities for mutual sharing, learning and development of the best practices included in this document.

FORWARD

Groundnut is undoubtedly the most popular legume crop in the farming systems of many developing countries including Nigeria. Unlike other cereals and legumes, all parts of the plant are valuable. The historic groundnut pyramids of Northern Nigeria and contributions of the crop to export revenue of Nigeria before the discovery of crude oil established an exceptional link between the crop and socio-cultural as well as economic growth of the country.

In the light of this, the successful implementation of the USAID funded Groundnut Scaling and BMGF funded Tropical Legumes (Phase III) Projects restored confidence amongst groundnut farmers in Nigeria. Operating in the same administrative units (States) on different aspects of groundnut, synergies between these projects provided opportunities of tactful integration at different points of the groundnut value chain. These projects extensively raised awareness, developed attitudes, skills and knowledge, fostered institutional and value chain linkages, enhanced the availability of quality seeds, provided mechanisms for market linkages and initiated processes required in the effective empowerment of women. The thematic studies carried out resulted in concrete opportunities for mutual sharing and learning, some of which have been used in the development of the best practices put together in this extension support document.

Also, Best Choices for Enhancing Groundnut Productivity in Nigeria builds on efforts of the Federal Ministry of Agriculture and Rural Development (FMARD) and the Extension Bulletins of the National Agricultural Extension and Research Liaison Services (NAERLS). The document covers the technical aspects of groundnut production, challenges of

popular groundnut pests/diseases and aflatoxin contamination. The document is a timely advisory supplement for front line staff of private and public extension services in Nigeria.

I give a standing ovation to ICRISAT, the Project Desk Officers and Extension Agents of the ADPs who contributed to the implementation of the two projects between 2015 and 2019. These ADPs are BSADP, JARDA, KARDA, KNARDA, KTARDA and SADP. The authors have aptly summarized their experiences into this advisory document. I strongly recommend ***Best Choices for Enhancing Groundnut Productivity in Nigeria*** to all groundnut value chain actors notably farmers, extension agents, private seed companies, seed certification officers, researchers, processors and regular consumers of groundnut and groundnut-based products. It is also a valuable document for future projects on groundnut in Nigeria.

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SECTION 1: INTRODUCTION

Groundnut (*Arachis hypogaea*), also known as Peanut, is an annual crop commonly grown by smallholder farmers. The name **Groundnut** can be confusing as the plant is not typically a **nut.** The plant itself grows above the ground while the nuts (pods) develop and mature underground. It originated from Central America, and its cultivation spread to the rest of the world as an oil-seed crop. In Nigeria, pyramid-like structures made of groundnut sacks were common features in several locations up to the 1970s. These locations included *Kofar, Mazugal, Brigade, Bebeji, Malam Madori and Dawakin Kudu.* The pyramid structures constituted tourist attractions in Northern Nigeria and symbol of the wealth of the country. These structures gradually disappeared when attention was shifted away from agriculture to crude oil after the 1970s. Recurrent rosette virus outbreaks of 1975, 1983, 1985 and 1988 also discouraged farmers from groundnut production.

However, Nigeria remains the third groundnut producing country in the world with annual production of 3.4MT coming after China (15,7 MT) and India (6.5MT). Across the world, the crop is widely cultivated and continues to be a major commercial crop in China, India, Africa and the United States of America (USA). While many varieties grown by small-scale farmers take between 120 to 150 days to mature, improved varieties take between 85-90 days. Production costs and profit margins can vary depending on knowledge, skills, farm management and disease/pest pressure and environmental factors notably rainfall and temperature. Overall, returns on investment (RoI) can be reasonable in cases where appropriate seeds and accompanying crop management practices are adopted **(Annex 1).**

Groundnut is produced in almost all the thirty-six (36) States of Nigeria. However, it is predominantly produced in nineteen (19) States namely: Adamawa, Bauchi, Benue, Borno. Jigawa, Kaduna, Kano, Katsina, Kebbi, Kogi, Kwara, Nassarawa, Niger, Plateau, Sokoto, Taraba, Yobe, Zamfara and The FCT (Abuja). The main agro-ecological zones for groundnut production in Nigeria are the Sahel, Sudan, Northern Guinea, most parts of the Southern Guinea and Derived Savannah **(Figure 1).**

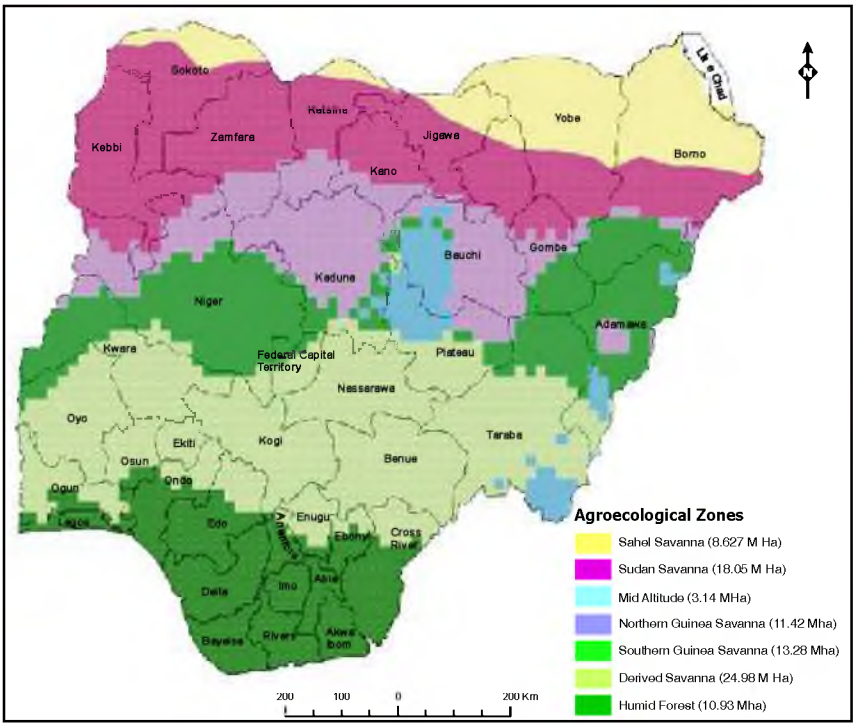


Figure 1: Main agro-ecological Zones of Nigeria

This document is a handy reference for Extension Agents, Private Seed Companies and Smallholder Farmers in their endeavors to contribute to rebuilding the groundnut pyramids of northern Nigeria. It complements efforts of the Federal Ministry of Agriculture and Rural Development (FMARD) initiated in 2014 to revive the groundnut industry and rebuild the groundnut pyramids by enabling small-scale farmers to have more money and safe groundnut for consumption, domestic and international trade.

SECTION 2: IMPROVED GROUNDNUT VARIETIES IN COMMERCIAL PRODUCTION IN NIGERIA

Plate 1:Harvest of SAMNUT 24 from a Dry Season Groundnut Production Farm in Kebbi State, North-western Nigeria

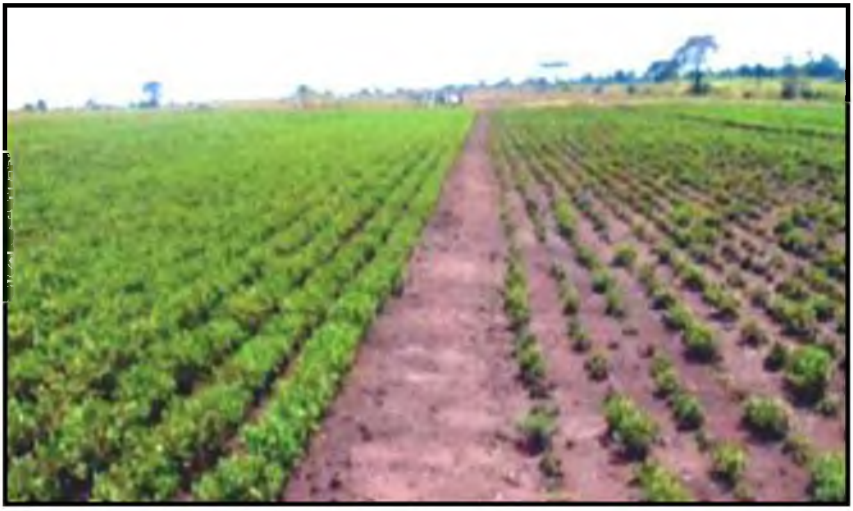


Plate 2: An improved groundnut variety resistant to rosette virus (left) and local groundnut variety susceptible to rosette virus (right)

A total of thirty-two (32) improved groundnut varieties have been registered and released for commercial production in Nigeria since 1990. Depending on resistance to disease pressure, grain and haulm yield potentials as well as adaptation to the main agro-ecological zones of Nigeria (Figure 1), six of these varieties are popularly grown by smallholder farmers (**Table 1**).

Upon registration and release, the key features of improved groundnut varieties are: **high grain yields-** estimated at 2-2.5 tons/ha instead of less than 1 ton/ha; **high haulm yields** - estimated to be between 2.5-3tons/ha,**early maturity** estimated at between 80-95 days, **high oil contents** estimated to be at least 45%, **resistance to popular groundnut diseases** notably early and late leaf spot diseases and the rosette virus, **small to medium size pods, and tan in color.** These features make them satisfy both consumer and market preferences.

Despite these potentials, several farmers cultivate a wide range of other varieties described as ***local***. As shown in **Annex 2,** local groundnut varieties are identified by the **names of individuals** who originally cultivated the varieties such as *Yar Ula, Yar Jigila*, etc., **color** of the kernel - *Jar-gyada, Mai Atamfa, Kampala,* etc., **kernel shape** - *Mota, Aska,* etc., **kernel size** - *Kwandala, Boleka,* etc., **growth behavior** - *Mai Jego, Yar Tsaye,* etc., and the **tribe** and/or **ethnic groups** predominantly cultivating the variety - *Bahausa, Yar Gwari,* etc. It should be noted that though ***Yar Dakar*** is considered a local groundnut variety, it is an improved groundnut variety officially endorsed in Nigeria from Senegal as SAMNUT 14. This implies that labels of registered and released crop varieties could eventually disappear through a wide range of socio-cultural transformations.

In 2018, three other groundnut varieties namely SAMNUT 27, SAMNUT 28 and SAMNUT 29 were registered and released by the national variety release committee. ICRISAT and the Institute for Agricultural Research (IAR) of the Ahmadu Bello University (ABU) are actively engaged to ensure that sufficient quantities of seeds of these improved varieties will soon be available for mass dissemination.

Table 1: Main Features of Improved Groundnut Varieties in Commercial Production in Nigeria

Plants and pods	Presentation of kernel	Major characteristics	Agro-ecological zones most suitable for cultivation
SAMNUT 21 	**SAMNUT 21** 	- Medium maturity: 115-120 days - Pod yield estimated at 2.5tons/ha - Haulm yield estimated at between 4-5 t/ ha - Oil contents estimated at 50% - Resistant to early and late leaf spot and rust - Kernel color: tan with white stripes	**Southern, Northern Guinea and Derived Savannas**
SAMNUT 22 	**SAMNUT 22** 	- Medium maturity 115-120 days - Pod yield estimated at between 2.0-2.5tons/ha - Haulm yield estimated at between 4-5tons/ha - Oil content estimated at 48% - Resistant to early and late leaf spot and rust - Kernel color: red	**Northern Guinea Savannas**
SAMNUT 23 	**SAMNUT 23** 	- Early maturity:90-100 days - Pod yield estimated at 2-2.5tons/ ha - Haulm yield estimated at 2tons/ha - Oil content estimated at 56% - Resistant to early and late leaf spot and rust - Kernel color: deep red	**Northern Guinea Savannas**

Plants and pods	Presentation of kernel	Major characteristics	Agro-ecological zones most suitable for cultivation
SAMNUT24 	SAMNUT24 	- Early maturity: 80-90 days - Pod yield estimated at 2- 2.5tons/ ha - Haulm yield estimated at 2.5-3tons/ha - Oil content estimated at 48% - Moderately resistant to early and late leaf spot - Resistant to rosette disease - Escapes end of season drought due to extra early maturity	**Sahel and Sudan Savannas**
SAMNUT25 	SAMNUT25 	- Early maturity: 90-95 days - Pod yield estimated at 2.5-3tons/ha - Haulm yield estimated at 2.5-3tons/ha - Oil content estimated at 46% - Moderately resistant to early and late leaf spot - Resistant to rosette disease - Escapes end of season drought due to extra early maturity - Kernel color: tan	**Sahel and Sudan Savannas**
SAMNUT26 	SAMNUT26 	- Early maturity: 90-95 days - Pod yield 2 -2.5 tons/ha - Haulm yield estimated at 2.5-3tons/ha - Oil content estimated at 49% - Moderately resistant to early and late leaf spot - Resistant to rosette disease - Escapes end of season drought due to extra early maturity - Kernel color: tan	**Sahel and Sudan Savannas**

Section 3: Recommended Groundnut Production Practices


Plate 3: Green Field Days provide opportunities for farmers to assess the performance of different groundnut varieties and showcase their individual performances


Plate 4: Leaf Spot Disease (Left) and packing out of weeds from farms by women (Right) at CDA/BUK

Better Choice to Make: ***Green and brown field days at appropriate stages of pod development are highly encouraged. They provide opportunities for all value chain actors to closely feel and appreciate the performance and challenges of improved and local varieties of groundnut. They are also occasions for value chain actors to socialize and mutually learn from each other***

Table 2: Recommended Groundnut Production Practices

	Recommended Practice	Rationale for Recommendation
a)	**Seeds and seed management**	
	1. Use improved groundnut varieties Depending on agro-ecological zone, select and plant any of the SAMNUT series.	Better pod and haulm yields per surface area placed under cultivation, better resistance to popular diseases (See Figure 1 and Table 1).
	2. Use well-filled seeds that are uniform in color, size and are not broken	This is a guarantee for better germination
	3. Shell seeds just before planting	When shelled and stored for long periods, groundnut seeds quickly lose the ability to germinate
	4. Sort/clean seeds into homogenous groups and/or color before planting	Small, shriveled and wrinkled seeds germinate poorly and produced weak and unhealthy seedlings
	5. Treat seeds with appropriate seed dressing chemical before planting *(Dress Force, Apron Plus,* etc.)	This protects the kernel from soil-borne pests and diseases and perhaps birds.
	6. Plant/sow when rainfall becomes more regular (or soil has enough moisture)	This means rains have become fully established
	7. Use a rate of between 35 - 40 kg per hectare of shelled seeds (or 70 -80 kg of unshelled seeds) and plant 2 seeds per hole	Plant spacing is one of the major factors affecting crop yield, especially groundnut
b)	**Agronomic Practices**	
	1. Select and use farms that are sandy-loam or loamy-sandy from which previous crops were cereals (sorghum, maize, millet or rice)	Eventual pegs (pods) need a favorable environment for germination and pod development. Harvesting is also easier as most pods come out easily.
	2. Land preparation – properly clear and harrowselected site properly with onset of rains	This facilitates aeration, the control of weeds and pests as well as water infiltration.
	3. Land preparation - ridge farm at a minimum depth of 30cm and 75cm apart (smaller spacing are feasible)	This provides favorable conditions for seed germination and pod development
	4. Use Farm Yard Manure (FYM) (if available); applying 2 tons per hectare	Use of organic manure improves soil nutrients, farm owner should expect many more weeds and termites
	5. Mix SSP (100 kg/ha) and NPK 15.15.15 (50kg/ha) and broadcast either during planting or after first weeding	As SSP is not always available, applying 100 kg/ha of NPK 15.1.5.15. could also suffice. Though not usually available, SSP is the most appropriate fertilizer for groundnut
	6. Plant/sow at 10cm x 75cm with 2 seeds/hole	Different spacing are also common, e.g. 20cm x 50cm 20cm x 75, either with or without ridge

	Recommended Practice	Rationale for Recommendation
	7. Carry out first weeding at 2-3 weeks after planting/sowing. Experiences exist with the use of different pre-sowing, pre-emergence and post-emergence herbicides in managing weeks.	Depending on the situation, weeds could appear earlier than 2 weeks. Weeds compete with growing groundnut plants, interfere with harvests and can harbor pests and diseases.
	8. Second weeding should be done between 6-8 weeks after planting/sowing. Experiences exist with the use of different post-emergence herbicides in managing weeks.	Eearthening-up is advised at this stage. There is need for extra care at this stage as the SAMNUT varieties continuously develop pegs until harvest
	9. Systematically remove physically weak stands, weeds and plants that are not the same like others	This action is very important if farm is for seed production
	10. In case of abnormalities on any part of the plant, spray with appropriate pesticide **(Annex 2)**and seriously consider leaving the using the farm to grow other crops for between two to three cropping seasons	Use agro-chemical only in case of observed attacks by pests and diseases such as Early Leaf Spot (ELS). Late Leaf Spot (LLS), Rust, Stem Rot, Rosette, aphids, Spider mite, White grub, termites, etc.
c)	**Harvesting, Bagging and Storage**	
	1. Harvest any time between 85- 90 days after planting, or as soon as inside shells show dark veins	Improved groundnut varieties could start sprouting if not harvested at the right time even if they are still producing pegs and flowering
	2. While harvesting, gradually pull stem and pods from the soil either manually (soft soils) or mechanically using a hoe or fork (hard dry soil) or even tractor	Overturn the whole plant with pods facing the sun This can be done with a groundnut digger or lifter
	3. Shake each stem lifted to remove soils attached	Pods with soil may contain hidden infections which could facilitate aflatoxin contamination
	4. Avoid mechanical damage on pods during harvesting	Damaged pods could facilitate infections leading to aflatoxin (see section on aflatoxin management)
	5. Air dry pods in a safe place (the farm or at home) for a minimum of 5 days after lifting or before stripping (removing from stems)	About half of the pods at harvest a lot of contain water. If not being used immediately, dry pods well to avoid deterioration and aflatoxin contamination
	6. Strip and shake pods until they rattle to check appropriate moisture contents during/before stripping	Rattling indicates absence of moisture
	7. Further sort, pour into homogenous bags before storage (if possible weigh the bags)	If more than one variety is to be stored, label them accordingly before taking them into storage location. Groundnut can also be stored in cartons or silos
	8. Store produce in clean bags in sufficiently ventilated places and regularly check to ensure that there are no rodents feeding on them	Place bags on wooden pallets in dry airy rooms

SECTION 4: AFLATOXIN CONTAMINATION AND MANAGEMENT OPTIONS IN THE GROUNDNUT VALUE CHAIN

Figure 5: Groundnut pods showing likelihoods of aflatoxin contamination

Plate 6: Quality Seeds of SAMMUT 25 ready for Planting (Left) and Cleaning and Sorting of groundnut Seeds by Women (Right)

Best Choice to Make: The effects of the consumption of aflatoxin contaminated foods by humans though gradual, is cumulative: ***aflatoxins cannot be eradicated through cooking and the body does not destroy or excrete aflatoxins***

4.1. What are aflatoxins

Aflatoxins are poisonous substances produced by some fungi (molds) on crops, foods and feeds. They have worldwide occurrence, usually in tropical and sub-tropical areas lying between latitudes 35° North and 35° South. Fungi of the *Aspergillus* group are responsible for secreting these toxins, mainly *Aspergillus flavus and Aflatoxin parasiticus.* They live in soils and decayed materials. When their spores are released, they infect crops on farms, harvested and processed products. The crops frequently affected by aflatoxins are groundnut, maize, sorghum, millet, rice, sesame, wheat, cowpea, spices and cassava. **Groundnut** is known to be the most common host of aflatoxins.

Plate 7: Apart from Groundnut, aflatoxin producing fungi are also a challenge to many other agricultural sector commodities (See Maize and Yams Chips above)

Aflatoxin contamination occurs in two different phases; the first phase occurs on the developing pods and the second phase after the crop matures. Many groundnut grains and seeds in Northwestern Nigeria are contaminated by aflatoxins with 25-83% of them exceeding permissible levels **(Annex 4)**. Adherence to good agricultural management practices by collaborating farmers of the Groundnut Upscaling and TL-III projects are leading to lower levels of aflatoxin in both local and improved groundnut varieties. This implies that the challenge posed by aflatoxins can be adequately addressed by farmers and extension agents working together.

4.2. Consequences of aflatoxin contamination

The consequences of aflatoxin contamination on human health, trade and nutrition can be significant. In general, aflatoxin contamination reduces the nutritional quality and market value of agricultural sector crops including groundnut. Prolonged consumption of aflatoxin infected foods lead to impaired immune function, stunted growth in children, disabilities and even death. Aflatoxin is also known to have adverse effects on reproductive health, liver cancer and hepatitis B and C. Most of the groundnut varieties and groundnut-derived products found on local markets in Nigeria contain varying amounts of aflatoxin - just like human beings in Sub-Saharan Africa who have different levels of the malaria parasite.

4.3. Factors influencing aflatoxin contamination before harvest

High soil temperature and late season drought stress are the two most important factors that concurrently promote pre-harvest aflatoxin contamination of groundnut. The main factors influencing pre-harvest contamination of groundnut by aflatoxin producing fungi are insect damage to pods and developing seeds. Similarly, stress to the plant caused by prolonged high temperatures and drought facilitate pre-harvest contamination. Prolonged and high temperatures as well as drought stress affect the physiology of plant rendering them susceptible to aflatoxin producing fungi. Drought stress reduces the natural defense mechanism of the plant against infection. Prolonged drought strains groundnut pods and kernel seed coat resulting in entry points for infection by aflatoxin producing fungi. Also, the likelihood of aflatoxin contamination is much higher during the main (wet) cropping season than in dry season.

Best Choice to Make: ***Pests notably termites can be adequately managed through the application of appropriate agro-chemicals (Annex 3). Termites create openings on groundnut kernels before harvest and during drying on farms thereby widening the possibility of aflatoxin contamination***

Hints for managing aflatoxin contamination before harvest

- Avoid farms with evidence of soil harbouring insects such as termites;
- Use farms with at least two years fallow; reduces buildup of aflatoxin producing fungi;
- Avoid using farms from which cotton, tobacco and tomatoes have just been harvested - these crops may harbor soil borne aflatoxin producing fungi;
- Use seeds of improved groundnut varieties;
- Dress seeds with appropriate chemical before planting
- Harrow and ridge properly beforesowing/planting;
- Maintain recommended plant spacing (see section on agronomic practices);
- Apply farm yard manure/between 2.5 and 3 t/h^{-1}before planting if available;
- Apply lime or gypsum (at 400 kg ha^{-1}or 35 days after planting), if available;
- Remove dead plants and unhealthy plants before harvest;
- Harvest the crop at right maturity;
- Early cessation of rains may necessitate irrigation, wherever possible;

4.4. Factors influencing aflatoxin contamination during harvest

Timely harvesting of groundnuts is necessary to reduce aflatoxin contamination. Delays in harvesting of groundnuts lead to poor quality seeds/pods due to possibility of injuries. Mechanical damage to pods or kernels during digging and threshing of groundnuts, provide entry points for invasion by aflatoxin producing fungi. Insect injury to groundnut pods or kernels might also lead to aflatoxin contamination.

Best Choice to Make: ***An analysis of samples of groundnut kernels and groundnut processed products collected from the 2016 and 2017 cropping seasons show that aflatoxin contamination are higher in local groundnut varieties than in the improved groundnut varieties being promoted by the TL-III and USAID groundnut technology scaling projects.***

Hints for managing aflatoxin contamination during harvest

- Check and harvest pods when mature (between 85-95 days for improved varieties)
- Avoid mechanical damage of pods during harvest;
- Place lifted plants upside down for between 5 to 7 days before stripping;
- Systemically remove mechanical and insect damaged pods while stripping pods;
- Separate the fully mature large pods (to be used for raw consumption) from the remaining produce (used for oil extraction).
- Regularly check pods during drying to remove damaged pods;
- Avoid mixing dried pods with those just harvested from farm-fields;
- Remove immature pods attached to haulms/fodder, if they are to be fed to lactating cattle;

4.5. Factors influencing aflatoxin contamination during storage

The importance of sanitation in storage locations in mitigating the incidence of aflatoxin contamination is imperative. Leaking roofs, improper ventilation, high-moisture content at storage locations can lead to infections and/or growth of aflatoxin producing fungi. Also, other products stored in same locations with groundnut and improper drying favor contamination and the development of aflatoxin producing fungi. Proper sorting before storage can eliminate damaged pods and reduce the likelihood of contamination and the growth of aflatoxin producing fungi.

Hints for managing aflatoxin contamination during storage

- Thoroughly clean storage facilities (containers and stores) before storage;
- Prevent insect damage to the pods during storage;
- Keep pod-filled bags on a wooden plank and store them in well ventilated, waterproof bags;
- Disinfect storage location before storing packaged pods;
- Remove pods in poor conditions before bagging;
- Keep bags of pods in ventilated stores that do not have leakages;
- If necessary, dry the stripped/threshed pods once again to maintain seed moisture below 8%.

SECTION 5: PRODUCTION, DISTRIBUTION AND MARKETING OF QUALITY SEEDS OF GROUNDNUT

Plate 8: A happy couple (left) confirms better yield (Right) from a farm devoted to the production of certified seeds of groundnut

Plate 9: Joint USAID and TL-III field monitoring enhanced outcomes

Plate 10: Veteran groundnut seed producer in Shagari LGA of Sokoto State

5.1. Three major seed classes in Nigeria

Seeds are generally the cheapest inputs in crop production and fundamental to increasing crop productivity. Response of seeds to fertilizer application and accompanying crop management practices equally depends on the quality of the planting material. It is common to find three classes of seeds: **breeder, foundation and certified seeds** (Figure 1).

Breeder Seeds: These are produced by plant breeders and seed technologists. The outcomes are usually 100% genetic purity due to strict field monitoring during production by the breeding team.

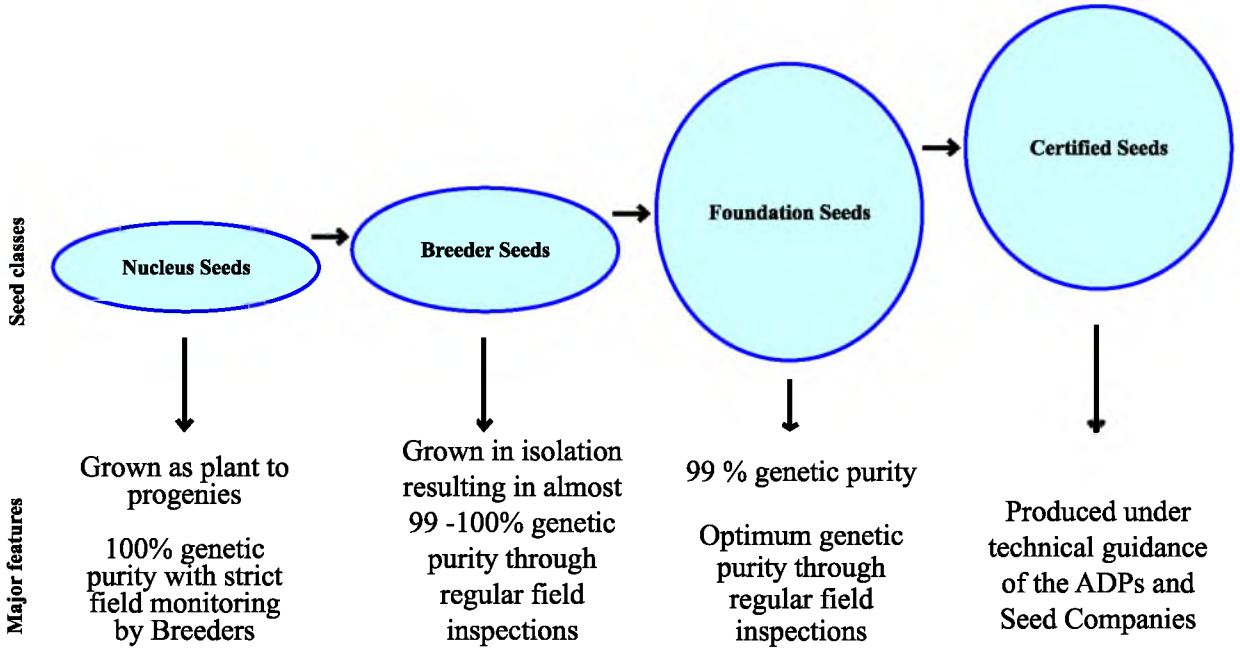
Foundation Seeds: An immediate outcome of breeder seeds are Foundation Seeds. A key point in the production of Foundation Seeds is prior indication of the availability of appropriate technical knowledge/skills within the organizations desiring to produce this seed class. Private seed companies and research institutions are mandated to produce foundation seeds in Nigeria.

Unlike other crops, groundnut has a number of limitations *a) it is a self-pollinating crop b) seed ratio is extremely low, c) germination viability rapidly drops six months after harvest (and further degrades if already shelled.* These features compel the National Agricultural Seeds Council (NASC) to tolerate a maximum of two stages in the production and distribution of Foundation Seeds.

Certified Seeds: Certified Seeds emanate directly from Foundation Seeds. They can be produced, distributed and marketed by farmer groups, representatives of farmer groups, commercial arms of ADPs or individuals.

Best Choice to Make: ***All seed classes are expected to be endorsed by Seed Certification Officers of NASC; this exercise usually ends up with appropriate field inspection reports***

Figure 1: Schematic linkages between different seed classes



All classes of seeds are sanctioned by a quality control mechanism undertaken by NASC known as **seed certification.** This entails prior declaration and subsequent field inspection by designated staff of NASC. Field inspections usually occur during **pre-planting stage, vegetative stage** (from planting to pegging), **reproductive stage** (pegging to pod maturity) and **during harvest.** Harvests from farms not declared or subjected to appropriate field inspections are considered as farmer's own seeds which could also be used in farmer-to-farmer seed exchanges. However farmers should be vigilant not to be dupped by other farmers.

Plate 11: A Seed Certification Officer of NASC (Left), regular back-stopping and extension support (Right) are instrumental in enhancing seed quality and adherence to recommended groundnut production practices

5.2. Dry season groundnut production

Since 2012, several initiatives confirmed the feasibility of producing groundnut in the dry season. Operations for dry season groundnut production normally start from October and continue to February. Groundnut production in the dry season has been successful in areas where irrigation facilities are available throughout the season or where the soil has enough moisture. Before sowing seeds, farms should be irrigated to ensure that soil moisture is sufficient. This should be repeated on the third day and thereafter with an interval of between 7 - 10 days depending on the intensity of drought and winds. The critical periods for irrigating groundnut production farms are: **flowering phase** (21-60 days), **peg formation stage** (40-45 days), and **maturity stage** (60-95 days).

Overall, dry season groundnut production is new and very challenging. These challenges include slow growth leading to delayed maturity, possible increase in the cost of fuel, break-down of water pump, water sources drying up, inadequate extension support, possible increase in disease and pest pressure notably lice (aphids), theft, unexpected onset of rains and destruction of crops and farms by birds, roaming chickens, cattle, sheep and goats.

Best Choice to Make: ***Despite the challenges of dry season groundnut production, it is a better option for securing quality seeds with less likelihoods of aflatoxins contamination and especially for meeting unexpected demand of quality seeds during the main cropping seasons.***

5.3. Groundnut Seed or Groundnut Grain

Differences between groundnut seeds and grains are not often evident to value chain actors. Table 3 provides some tips for differentiating groundnut seeds from groundnut grains.

Table 3: Differentiating Groundnut Seed from Groundnut Grain

Groundnut Seed	Groundnut Grain
Mostly used for planting	Mostly used for consumption
Carrier of improved technologyand remains alive and healthy	Does not necessarily carry improved technologies and may not be alive
Has a much higher germination percentage	May or may not germinate
Uniform in color and other physical traits	Not necessarily uniform in colour and other physical traits
Must reproduce in subsequent cropping seasons	Does not necessarily reproduce in subsequent seasons
Normally treated with agro-chemical (toxic) either before planting or storage	Should not be treated with toxic chemicals
Usually traced to a source and/or, properly packaged and truthfully labelled before selling	Tracing the source may not be necessary, except in case of real trouble
Generally sold at a higher price	Sold at a lower price
Basic tool for sustained food and nutrition security	Not applicable
Medium of rehabilitation of agriculture after natural disasters and/or insurgency	Mostly used as a package for direct consumption to affected people (displaced persons)
Free from sand, dry stems, roots and foreign materials	Not always free from foreign materials including pests and diseases

5.4. Distribution and marketing of quality seeds of groundnut

Though unpredictable, the annual demand for certified groundnut seeds is usually greater than demand. In conformity with the 2015 Nigerian Seed Policy, certified seeds are produced, distributed and sold by farmer groups and private seed companies. In general, due to the high cost of inputs and difficulties to access them when required, farmers tend to grab and plant any seed they can access, including popular local varieties. The situation of groundnut is complicated by its bulkiness, high seed rate (requiring large amounts of seeds to plant per surface area) and low seed viability (inability to be stored for more than one cropping season without losing its germination power).As should be expected, this action could result in low yields and corresponding low returns on investments.

In order to address this challenge, the Groundnut Upscaling and TL-III projects promoted community-based seed production (CBSP) to boost the availability of certified seeds. This option of seed supply proved to be useful in ensuring that quality seeds is available. This provided an opportunity for some private seed companies to link up and use CBSP as out-growers. Contract seed supply between CBSP and agro-service input providers, agro-processors is also a tool for motivating farmer groups to use appropriate fertilizers, pesticides and improved groundnut varieties. Extension agents can play a central role in identifying and supporting farmer groups to become veritable community-based seed business units in their

Best Choice to Make: ***Extension agents can play a central role in identifying and supporting farmer groups to emerge as veritable community-based seed business units in their communities.***

SECTION 6: CONSUMING HEALTHIER GROUNDNUT AND GROUNDNUT-BASED PRODUCTS

The consumption of groundnut and groundnut products varies greatly though they can be quite localized. Apart from soya beans and fish, groundnut constitutes a substantial portion of household protein intake in Nigeria and many other countries in Africa and Asia (Table 4).

Plate 12: A wide range of groundnut-based products commonly found in Nigeria

All parts of the groundnut plant are valuable and useful. The kernel can either be used as seeds or fed directly to domesticated birds (chickens). Before harvesting, the roots of groundnut fix atmospheric nitrogen and therefore has the potentials of reducing the extent of chemical fertilizers required to boost crop production. Groundnut haulms (also known as fodder) are regularly used to feed sheep, goats and cattle and as fuel for heating. Groundnut is also one of the most valuable feeds for compounding livestock and poultry feeds. In industry, groundnut has a variety of uses; groundnut oil contributes to making paint, varnish, lubricating oil, leather dressings, polish, insecticides, etc. Soap is also made from groundnut sludge and many cosmetics contain groundnut oil and or its derivatives. Similarly, groundnut shells are used in the manufacture of plastics, wallboards, abrasives, cellulose and glue.

Table 4: Nutrients values of different agricultural crops

Crop	Energy (Kcal per kg)	Fat (Grams per kg)	Protein (Grams per kg)
Legumes			
Groundnut	**5,670**	**50**	**258**
Soya-beans	4,160	200	365
Common Beans	4,330	8	226
Roots and Tubers			
Cassava	1,490	2	12
Yam	1,180	2	15
Potatoes	1,100	2	18
Cereals			
Rice	3,610	10	65
Maize	3,530	38	93
Animal Source			
Eggs	1,580	112	120
Beef	1,610	79	195
Fish	2,550	74	470
Fruits and Vegetables			
Orange	450	2	9
Carrots	350	0	7
Cassava leaves	230	3	30

Source: GIZ/WOFAN Nutrition Training Support Materials (2015)

Best Choice to Make: ***Spit out any groundnut or groundnut-based products with a strange taste while eating them; this could be an indication of aflatoxin contamination***

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Annex 1: Per Hectare Costs and Expected Returns of Producing Groundnut in Selected States ofNorthwestern Nigeria (Naira)

Description of Inputs /farm operations	Jigawa State		Katsina State		Kano State		Kebbi State		Sokoto State		Overall for the States		
	Mean Cost	%	Mean Cost	%	Mean Cost	%	Mean Cost	%	Mean Cost	%	Totals	%	Mean ± Standard deviation
1. Land rental (rate /ha)[1]	9,000	5.72	8,500	6.31	9,600	6.43	7,000	5.37	8,100	6.99	42,200	6.14	8,440 ± 981
2. Seeds (70 kg/ha)[2]	24,600	15.61	19,200	14.25	20,000	13.41	20,833	15.99	11,960	10.33	96,593	14.06	19,318.6 ± 4,604
3. Fertilizers (NPK and SSP) (1 bags of NPK to 3 bags of SSP per ha)[3]	22,500	14.50	30,000	22.27	22,900	15.35	23,000	17.65	23,000	19.86	121,400	17.66	24,280 ± 3,204
4. Pesticides (all categories)[3]	8,850	5.61	3,200	2.37	2,750	1.84	3,742	2.88	4,920	4.25	23,462	3.41	4,692.4 ± 2,461
5. Labor for different farm operations(a)[4]	74,100	47.08	58,750	43.6	83,800	56.17	43,149	33.11	53,460	46.16	313,259	45.59	66,651.8± 16,695
Total cost of farm operations	**139,050**	**NA**	**119,650**	**NA**	**139,050**	**NA**	**97,724**	**NA**	**101,440**	**NA**	**596,914**	**NA**	**119,383 ± 19,778**
Imputed cost of farmer's time[5]	18,000	11.43	15,000	11.14	10,000	6.70	32,500	24.94	14,300	12.34	89,800	13.07	17,960 ± 8,616
Desired profit margin per kilogram of seeds produced by community-based seed producers	92.83	0.06	108.77	0.08	113.51	0.07	84.26	0.06	75.58	0.07	474.95	0.06	94.99 ± 16.04
Total costs per hectare (₦)	**157,144**	**100**	**134,732**	**100**	**149,195**	**100**	**130,310**	**100**	**115,816**	**100**	**687,197**	**100**	**137,439 ± 16,219**
Average yield per hectare (kg)	**1,000**	**NA**	**954**	**NA**	**800**	**NA**	**960**	**NA**	**750**	**NA**	**NA**	**NA**	**892.8 ± 110**
Unit price per kg of seeds produced (₦)	157.14	NA	141.23	NA	186.49	NA	135.74	NA	154.42	NA	NA	NA	155 ± 19.7
Agreed market price per kg(₦)	**250.00**	**NA**	**250.00**	**NA**	**300.00**	**NA**	**220.00**	**NA**	**230.00**	**NA**	**1250**	**NA**	**250 ± 30.8**
Expected total revenue per hectare (₦)	**250,000**	**NA**	**239,600**	**NA**	**240,000**	**NA**	**211,200**	**NA**	**172,500**	**NA**	**113,300**	**NA**	**222,660 ± 31,553**
Gross Profit Margin (₦)	**92,856 (37%)**	**NA**	**103,268 (43%)**	**NA**	**94,805 (40%)**	**NA**	**80,890 (38%)**	**NA**	**56,684 (32%)**	**NA**	**428,503**	**NA**	**85,700 ± 18,082**

[1]Imputed cost as most land belong to farmers, [2]foundation seeds provided, [3]Open market cost, [4]Mostly done by women and children in all the States

a) Farm operations requiring the use of labor include: land clearing, ploughing/ridging, shelling, planting, weeding, fertilizer application, spraying for pesticides, stripping, harvesting, drying and transportation of inputs/pods and haulms from farm-fields to homes

Annex 2: Local groundnut varieties in project implementation States

S/N	Description of varieties according to:						
	Origin/Location	Tribe/ethnic group	Kernel Size	Color of kernel	Name of Individual	Shape of kernel	Growth Behavior of the plant
1	Kwankwaso	Bahausa	Bolaka	Jar Gyada	Yar Gaga Juya	Aska	Mai Jego
2	Yar Gari	Yar Gwari	Kwandala	Mai Bargo	Yar Kwala	Mota	Mai Yado
3	Yar Rano	Bagobira	Sola	Kampala	Yar Sotal		Mai Zube
4	Yar Dakar		Gwarama	Mai Atamfa	Mai Wada		Tattabara
5	Yar Lafiya			Mai Zabuwa	Yar Ula		Yar Malaka
6	Yar Madani			Farar Gyada	Yar Sangerawa		Yar Tsaye
7	Yar Madali				Yar Ladan		Yar Kwance
8	Yar Maradi				Yar Baushe		Mai Mota
9	Yar Gidima						Yar Jigila
10	Yar Midili						
11	Yar Neja						
12	Yar Tambuwal						
13	Yar Zamfara						
14	Yar Jamaiya						
15	Yar Mali						
16	Yar Malikawa						
17	Yar Kosoma						
18	Yar Jam'iya						

Annex 3: Fertilizers and agro-chemicals recommended for groundnut production

S/n	Trade Name	Method of application	Indications	Dosage
1	NPK (15-15-15) or NPK 10:20:10	Broadcast or spot placement	Additional nutrient source for the plant	50 kg per hectare
2	Single Super Phosphate (SSP)	Broadcast or placement	Additional nutrient source for the plant	100 kg per hectare
3	Apron star Apron plus Seed dress Seed plus	Seed dressing	Treatment of seed before planting	As directed by the manufacture specified on the label
4	Fungicide (mancozeb)	Spraying	Treatment of seedlings	As directed by the manufacturer
5	Glyphosate (round up)	Spraying	Management of weeds before ridging or ploughing	As directed by the manufacture specified on the label
6	Butachlor (butaforce), pendementhlin (pendilin)	Spraying	Suppress the emergence of weeds	As directed by the manufacture
7	Chlorphrifos (termikill, termiforce, etc.)	Spraying	Controls termite attack/outbreak	As directed by the manufacture specified on the label
8	Cypermethrin (Cyperforce, Best cypermethrin) Cypermethrin+Dimetrate, Lambdacyhalothriine e.g. Attack or Karate)	Spraying	Control infestations by insects	As directed by the manufacture specified on the label
9	Aluminum Phostophide (Phostoxin)	Wrap in a muslin cloth	Management of insects during storage	As directed by the manufacture specified on the label
10	Abamectin 1.8% (Punch)	Spraying	Management of spider mite	As directed by the manufacture
11	Imidacclorid (Imiforce, MandoImicot	Spraying	Management of aphids	As directed by the manufacturer
12	AmpligoTihan	Spraying	Management of larvaeand insects	As directed by the manufacturer

Annex 4: Permissible levels of aflatoxins in human foods

Commodities		Aflatoxin B_1 (AfB_1)			Total Aflatoxin			
		EU	Nigeria	US	EU	Nigeria	US	Codex Alimentarius
All foods		Na	Na	Na	Na	Na	20	Na
Maize	Grains	Na	2	Na	Na	4	Na	Na
	Flour	Na	2	Na	Na	Na	Na	Na
	Grits	Na	2	Na	Na	Na	Na	Na
Sorghum		Na	Na	Na	Na	10	Na	Na
Rice		Na	Na.	Na	Na	Na	Na	Na
All cereals and products derived from cereals including processed cereal products except those specified below		2	Na	Na	4	Na	Na	Na
Maize and rice to be subjected to sorting or other physical treatments before human consumption or use as ingredients in foodstuff		5	Na	Na	10	Na	Na	Na
Processed cereal-based foods and baby foods for infants and young children		0.10	Na	Na	Na	Na	Na	Na
Dietary foods for medical purposes intended for infants		0.10	Na	Na	Na	Na	Na	Na
Groundnuts (kernels and in-shell)		Na	Na	Na	Na	20	Na	Na
Groundnut cake (Kulikuli)		Na	2	Na	Na	4	Na	Na
Groundnuts and other oilseeds to be subjected to sorting or other physical treatments before human consumption or used as ingredients in foodstuffs except those for crushing for vegetable oil extraction		8	Na	Na	15	Na	Na	Na
Groundnut, oil seeds and processed products intended for direct human consumption or use as ingredient in foodstuff except crude vegetable oil destined for refining and vegetable		2	Na	Na	4	Na	Na	Na

About ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in the drylands of Asia and Sub-Saharan Africa (SSA) on five highly nutritious drought-tolerant crops: ***chickpea, pigeon pea, pearl millet, sorghum and groundnut.*** Covering 6.5 million square kilometers of land in 55 countries, the dryland tropics has over 2 billion people, and 644 million of these people are the poorest of the poor. ICRISAT and its partners help empower these resource-limited people to overcome poverty, hunger malnutrition and manage their environments through better agriculture.

The Vision of ICRISAT is

A prosperous, food secure and resilient dryland tropics

The Mission of ICRISAT is

The headquarters of ICRISAT is in Hyderabad, Telangana State of India, with two Regional Offices in Nairobi (Kenya) and Bamako (Mali), and Country Offices in Niger, Nigeria, Zimbabwe, Malawi, Ethiopia and Mozambique. In Nigeria, ICRISAT is located within the premises of the Kano Station of the Institute for Agricultural Research (IAR) of the Ahmadu Bello University (ABU) - Zaria.

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We **believe** all **people** have a **right** to **nutritious food** and a **better livelihood.**

ICRISAT works in agricultural research for development across the drylands of Africa and Asia, making farming profitable for smallholder farmers while reducing malnutrition and environmental degradation.

We work across the entire value chain from developing new varieties to agribusiness and linking farmers to markets.

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