EXPANDING EXPORT OF SESAME SEED AND SHEANUT/BUTTER THROUGH IMPROVED SPS CAPACITY BUILDING FOR PUBLIC AND PRIVATE SECTORS

TRAINING MANUAL

FARMER'S GUIDE FOR THE FRODUCTION AND POST-HARVEST HANDLING OF SESAME PRODUCTS IN NIGERIA

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This document presents "Farmer's Guide for the Production and Post-Harvest Handling of Sesame Products in Nigeria".

This document has been prepared in consultation with the project colaborating instititutions/agencies and several sector stakeholders.

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Fo more information on NEPC: www.nepc.gov.ng

For more information on STDF: www.standardsfacility.org

For more information on ITC: www.intracen.org

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Note or Acronyms or Abbreviations

This page should contain the list of abbreviations within the document. It can be named either Note or Acronyms or Abbreviations.

The following abbreviations are used:

IITA	International Institute of Tropical Agriculture
UNCTAD	United Nations Conference on Trade and Development
ITC	International Trade Centre
WTO	World Trade Organization
STDF	Standards and Trade Development Facility
NAFDAC	National Agency for Food and Drug Administration and Control
NEPC	Nigerian Export Promotion Council
NCRI	National Cereals Research Institute
NSPRI	Nigerian Stored Products Research Institute

INTRODUCTION

Food safety has become a serious societal issue because of pathogens and food contamination. Safe produce begins with the production and handling practices on the farm. A sesame seed grown and sold with little biological contamination is less likely to result in health hazards caused by poor handling during later preparation stages. Farmers/producers have the critical job of minimizing product contamination by learning about potential sources of contamination and by using Good Agricultural Practices (GAPs), e.g., a set of recommendations that can help improve the quality and safety of the produce grown.

Good agricultural practices (GAPs) at the farm level involve multi-faceted efforts at ensuring that foods are safe for human consumption. There are a variety of GAPs that can be instituted at the farm level. Contamination of farm goods affects both consumers and agricultural producers. Thus, providing safe foods and promoting safety for humans and the environment include all the steps in the production chain from farm to consumer.

GAPs are a set of recommendations to improve the quality and safety of sesame products. Failure to institute a GAP program allows the risk of contaminated food products in the production process. GAP programs is meant to help farmers self-audit their operations of producing, post-harvest handling (e.g. processing, drying, storage, and transportation) to safeguard sesame products, the environment, and both the consumers and producers.

After identifying the risks that may exist within a producer's specific operation, a series of action steps can be developed to measure, monitor, and, if necessary, modify procedures designed to reduce these risks. By using a food safety plan that tracks and documents procedures, a producer has a series of information and records that demonstrate progress toward the reduction of risks for the operation.

EXECUTIVE SUMMARY

Sesame farmers/producers and their employees have the critical job of production of safe produce by having access to appropriate information and practices to minimizing and/or eliminate potential sources of hazards by following recommended practices. These recommendations, e.g., general guidelines elaborated in the manual can be adapted and/or incorporated at any stage, focusing a number of primary components displayed into six main chapters including:

1. Economic Importance of sesame;
2. Agricultural Practices: Pre-Season Activities;
3. Plant Protection Practices: Season Activities;
4. Sesame Production Requirements: Season Activities;
5. Plant Development and Recommended Practices: Season Activities;
6. Harvesting and Post-Harvest Handling Practices: Post-Season Activities.

This guide provides a brief overview of the concept of GAPs and highlights some of the potential consequences of not instituting GAP guidelines into a farm's operation. Not instituting GAP guidelines into a farm's operation allows consumer's exposure to potential contamination risks. Therefore, GAP guidelines should be a priority for all farmers since they benefit both consumers and producers.

GAPs can help trace contaminated foods back to the "handlers and growers" responsible for unsafe agricultural products. Besides the risks at field level, an important aspect of each farm operation is the post-harvest handling of sesame products because of the risk of exposure to contaminants (or cross-contamination) during storage, transportation and distribution of products. Preventing contamination at all possible sources on the farm and during post-harvest handling is critical because of the impact on both consumers and producers.

Quality control and Food safety programs should be instituted to prevent foodborne illnesses and food contamination starting at field level throughout the whole production and post-harvest handling processes from farm to consumers' table. This manual is necessary for all agricultural operations. Self-audits should be conducted on a regular basis to determine whether a farm meets individual, government, and/or international GAP standards.

For sesame production, this manual displays a set of recommendations that can help improve the quality and safety of the produce grown. The purpose of the manual being therefore to provide farmers/producers and marketers, and middlemen with the requisite knowledge and skills, strengthening the productivity, improving competitiveness, supply identified market

outlets with good quality product and thus enhance the income and thereby well-being of farmers/producers.

The current guide prepared under the STDF Project #172 for sesame production and post-harvest handling is conceived to serve as a manual and reference for farmers, and sesame producers. It has been designed in a way that extension agents, trainers and other interested users would also find it beneficial.

1. Economic Importance of Sesame

Chapter 1 - Economic Importance of Sesame

1.1. Production

Global production of sesame seed is estimated by FAO at 3.3 million metric tons (MT) per year (2006) having risen from 1.4 MT in the early 1960s. The largest producers are China and India, each with an annual harvest of around 750,000 MT followed by Myanmar (425,000 MT) and Sudan (300,000 MT).

Photo: B. Doko

Sesame has important agricultural attributes: it is adapted to tropical and temperate conditions, grows well on stored soil moisture with minimal irrigation or rainfall can produce good yields under high temperatures, and its grain has a high value (Mal Bennett).

Of an estimated 3.5 million hectares of land available for the crop, only about 335,000 ha are currently used for sesame, suggesting a vast potential for increased production of the crop in Nigeria.

Sesame Production Areas in Nigeria:

- The major producing areas in order of priority are Nasarawa, Jigawa and Benue States. Other important areas of production are found in Yobe, Kano, Katsina, Kogi, Gombe and Plateau States.

The quality type of Sesame produced in Nigeria

- There are 2 types of sesame produced in Nigeria:
  - white/raw, food-grade sesame used in the bakery industry, and
  - brown/mixed, primarily oil-grade sesame.
- The white (food grade) seed is grown around the towns of Keffi, Lafia, Doma, in Nassarawa state, Taraba state, and Makurdi in Benue state.

- The brown/mixed seed grows in the North, in Kano state and in Jigawa state around Hadejia, and somewhat in the Southern part of Katsina State.

1.2. Utilisation

Sesame, *Sesamum indicum* L., is an ancient oil crop supplying seeds for confectionery purposes, edible oil, paste (tahini), cake and flour. It is typically a crop of small farmers in the developing countries. The taste of sesame differs among varieties, and can be negatively affected by poor post-harvest processing and storage.

Part of the attraction of sesame for baking is undoubtedly its high fat (50% oil) and high protein content (up to 25% protein by weight). Sesame oil carries a premium relative to other cooking oils and is considered more stable than most vegetable oils due to antioxidants in the oil. The antioxidants inhibit the development of rancidity in the oil. In the food industry, where synthetic antioxidants are used extensively, there is an increasing demand for more natural products.

Sesame is commercialized in a number of forms. Most sesame is processed directly into oil but can also be sold at various stages of processing, for various uses, such as meal, paste, confections, and bakery products (Fig. 1). In Nigeria, sesame is grown for its seed, and the primary use of the sesame seed is as a source of oil for cooking. It is also common to find roasted sesame seeds sold (either sole or with groundnuts) and eaten as snack among rural and urban dwellers across Nigeria.

With the growing demand for organically grown food there is a market for sesame products produced under organic conditions. During sesame seed extraction process, the remaining meal, e.g. extraction by-products is a high protein material suitable for feeding to livestock. Although at this time sesame oil is used almost exclusively for human food consumption, it has potential for a variety of industrial uses, as do most vegetable oils. The young leaves may also be eaten in stews, and the dried stems may be burnt as fuel with the ash used for local soap making.

Oil

Biscuits

Bun

Fig. 1: Illustration of some uses of sesame

Source: USAID-MARKETS (2009)

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1.3. Markets and Economics

In 1993, the world trade in sesame seed was 486,000 t. Japan was the largest importer taking 24% of the world imports. The second largest importer was the USA with 8% of world imports. It is forecast that the imports of sesame seed will grow at between 6 and 8% per annum until the year 2012.

In Nigeria, Sesame is an important export crop and the country has a substantial role in the global sesame trade. Annual exports of sesame from Nigeria are valued at about US$20 million and Nigeria is the primary supplier of sesame seed to the world's largest importer, Japan.

Photo: B. Doko

In response to the growing export market demand, Nigeria's production of the crop has consistently increased from about 15,000 MT in 1980, to about 100,000 MT in 2006. Most sesame exported from Nigeria is in primary form. Over 70% of its export is handled by 4 major export companies: Olam Nigeria, Akkay Limited, Dangote and Dantata. The Sesame (or beniseed) is an oil seed grown predominantly as an export crop. Annual export from Nigeria is estimated at about US$ 20 million with potential of increasing tenfold. Global exports of sesame seed are estimated to have reached 675,000 MT in 2000, having risen from 427,000 MT in 1988. India is now the single largest exporter of sesame seed, with exports of some 180,000 MT, with Sudan in second position, exporting over 138,000 MT per year (USAID-MARKETS, 2009).

However, in the fields of sesame production, and post-harvest handling business, producers, mainly smallholder farmers are facing strong constraints and challenges to achieve significant increases in their incomes owing to factors including among others, poor knowledge good agricultural practices, and inadequate technical support from local extension services, and the poorly developed market opportunities.

2. Agricultural Practices: Pre-Season Activities

2.1. Site Selection, Seed Variety Selection and Seed Sources

Site selection,

Sesame is adaptable to many types of soil but it does best on well-drained soils. The crop is usually produced on upland plains while depressions and valleys with poorer drained soils are generally unsuitable.

It does reasonably well on poor soils; sandy loams are preferred. Once established, it can tolerate short periods of drought, but is very intolerant of water logging. It has poor ability to compete with weeds in the early stages.

Tips in selecting appropriate sites include:

- select land that is fairly flat and well drained (not water logged);
- avoid depressions and valley bottoms such as fadamas with poorly drained soils;
- select land that is fertile and has sandy loam soil free from concretions;
- sesame can be grown in rotation following yam, sorghum, maize, groundnuts, cotton, millet, or cowpea;
- it can also be grown as a mixed crop with sorghum, millet, and other cereals.

Variety Selection and Seed Sources

Seed Selection:

There are many varieties of sesame available from which farmers can select. The major varieties used are indicated in table 1. However, the two types of sesame preferred/produced in Nigeria include:

- the white/raw, food-grade sesame used in the bakery industry, and
- the brown/mixed, primarily oil-grade sesame.

Photo: B. Doko

The types of sesame seed produced and their growing location in Nigeria are shown in table 2.

1. Always choose seeds of the same type and variety.
2. Mixing different seed sources or varieties will result in uneven height, maturity and seed quality.

Table 1: Basic characteristics of released sesame varieties [by the National Cereals Research Institute (NCRI), Badeggi, Nigeria]

Sesame Variety	Days to Maturity	Characteristics of Seed		% Oil content	Potential yield (kg/ha)
		color	Size		
NCRIBEN-01M	102-115	White	3	45	1000
NCRIBEN-02M	102-115	Light brown	3	45	750
NCRIBEN-03M	125-140	White	2	40	600
E8	90	Light brown	3.6	50	1000
Yandev 55	125	Light brown	2.5	45	600

Table 2: the type of sesame seed produced and their growing location in Nigeria

Sesame Quality Grade	The Sector of usage	Location	
		State	Place/town
White/raw (food grade)	bakery industry	Benue state	Makurdi
		Taraba state	
		Nassarawa state	Keffi, Lafia, Doma
Brown Mixed (oil-grade)	Oil industry	Kano state	
		Jigawa state	Hadejia
		Katsina State	

3. Always choose seeds of the same type and variety.
4. Mixing different seed sources or varieties will result in uneven height, maturity and seed quality.

Note: The choice of which variety to grow is rather market demand-driven business. If the above varieties are not available, make sure to use clean and healthy seeds from a reliable source.

Seed Requirements

Sowing style

- **3-5 kg/ha** in furrow sowing, and
- **8kg/ha** in broadcasting
- Increase the planting rate if the seeds are planted deep, soil moisture is limited, soil temperature is cool, or the soil is compacted, cloddy, or trashy;
- Decrease the planting rate if the soil is well prepared and have adequate moisture**;**
- Distance in between furrows: **75 cm x 75 cm**; **90 cm x 90 cm**; **100 cm x 100 cm**.

- a closer row spacing for irrigated or high rainfall areas and
- a wider spacing for dry areas.

2.2. Field Preparation

During the land preparation, choose the tillage practices that will ensure to keep the soil in its best physical condition for a favourable crop's growth and development. The major land preparation techniques used are:

- Clearing (slashing the weeds)
- Ploughing, and
- Harrowing

Plough and harrow the soil to a depth which will physically support the plant and allow the use of sufficient moisture and nutrients; sufficient enough to control weeds; and must leave the soil surface level.

- A level field improves water use efficiency, helps control in crop weeds and allows the rapid removal of excess water.
- Level the soil by ploughing and harrowing.
- Make the furrows at desired depth and distance during the last ploughing

Land clearing

The land can be cleared by slashing the weeds either manually or mechanically. Another option for clearing is to use herbicides such as *Glyphosate* (*Roundup*).

Clear the land free of weeds and gather the debris to the side of the field before the onset of rains. The debris could be burnt especially if the previous crop had evidence of pests/diseases that could be carried over to the new crop.

Ploughing

The current recommended practice in Nigeria is to plough and harrow the land to obtain a fine tilt and then plant on a "flat bed" at specified row spacing to achieve good ground cover.

Ploughing turns the soil over to cover the weeds that are already growing in the plot to be used. It increases soil fertility through decomposition of weeds and increases porosity of the soil making the crop to develop a big root network. For sesame, which has an extensive root system, good ploughing is critical to the effective performance of the crop.

- Ploughing can be done using the hoe, animal drawn plough and tractor drawn plough.
- Ploughing should be carried out after the first set of rains to ensure that the land is soft enough for penetration by implements.
- Where possible, ploughing with tractor drawn plough is recommended.

Harrowing

Harrowing is carried out to further turn and break the soil clods after ploughing. It creates a soft bed, increases the capacity of the soil to absorb and hold water for the crop to grow well, thereby increasing growth and yield.

- Harrowing can also be done with the hoe, animal drawn harrows and tractor drawn harrows
- Carry out harrowing one week after ploughing
- Ensure that the soil lumps are loosened into fine texture for easy germination and rooting of the sesame seedlings.

Source: httpcorn.agronomy.wisc.eduManagementimagesL007FieldCultivator2.jpg

Crop Rotation

There are various advantages in including sesame in a crop rotation system. If sown after a leguminous crop, sesame can benefit from the residual nitrogen.

- Where sesame is rotated with a cereal, there can be mutual benefits in weed control.

Sowing

As sesame seed is small, sowing depth should be **no greater than 2.5 cm** and

the seed should be sown **into moist soil**.

Application of Fertilizers

Sesame requires:

- 30-60 kg nitrogen,
- 10-15 kg phosphate,
- 10-15 kg potash.

Because of the high cost of fertilizer, three (3) bags of **NPK fertilizer (15:15:15)** are recommended for one hectare (USIAD MARKETS, 2009).

- Split the fertilizer application in two applications:
  - **2 bags** of fertilizer are broadcast during land preparation and harrowed in.
  - **1 bag** of fertilizer is side dressed during the first weeding, that is 4-5 weeks after sowing.

- It is also recommended to apply **5 tons of compost** or **farm manure** during land preparation.

1. **Where soil fertility is fair, Urea can be used in place of NPK**.
2. **When nutrients are adequate, leaves of sesame remain green before and after flowering**.

The fertilizer requirements for sesame will depend on the fertility of the soil, which will, in turn, vary with soil type and previous land use.

- An application rate of **60 kg/ha** of nitrogen is likely to be adequate. The nitrogen should all be applied at sowing as there appears to be no advantage in a split application.

- Most sandy loam soils can be expected to be deficient in **P**, **K**, **S**, **Cu**, **Zn** and **B**. Unless the area has received prior applications of fertilizer, an application of at least **100 kg/ha** of both single superphosphate plus trace elements and muriate of potash is warranted.

- The clay soils tend to be more fertile. They do not require K, but applications of P, S, Cu, Zn and B will be needed.

Water requirements

- Sesame grows well in areas with **16 - 18 inches** of annual precipitation.
- Sesame needs water during the seedling and flowering stages

3. Plant Protection Practices: Seasons Activities

3.1. Weeds

Weeds are the unwanted plants that compete with sesame for nutrients, moisture, and sunlight which can decrease the crop quality, higher the production costs due to increase cultivation and hand weeding, and considerably reduce the crop yields. They also serve as the alternate hosts of insect/mite pests and diseases.

Sesame grows slowly during the early stages of growth and is not strongly competitive with weeds. However, Poor weed control early in the life of the crop can result in greatly reduced crop yields.

Note:

- The weed-bearing seeds that are removed should not be placed in compost pile for the seeds may not be killed in the process of decomposition. The compost might be the source of the reintroduction of weeds into your fields.
- Sesame naturally grows slowly for the first 3 weeks after emergence and is therefore not a good competitor with weeds. This makes it particularly important to ensure a weed free field during the early stage of its growth.

Weed control

Improved weed control systems will contribute to increased net returns of the crop. The weed control is usually achieved the old-fashioned way, through pre-plant tillage and using a row crop cultivator once or twice after the crop has become established.

Care should be given with pre-plant tillage to maintain soil moisture.

Photo: Carey L. Biron, http://www.ipsnews.net/2012/06/calls-for-an-african-green-revolution-only-smarter/

Generally, sesame fields show abundant weed growth. Traditionally, hoe weeding is done at least twice. Sometimes hand pulling of weeds is done.

The weed control is achieved:

- Thorough land preparation, example: by ploughing and harrowing
- During the seed bed preparation, make sure that the seed bed is free of weeds.
- Through appropriate usage of fertilizer: Place the fertilizer where the crop has the access to it but the weeds do not. This allows the crop to be more competitive with weeds.
- By keeping the surroundings of farm free of weeds, unless they are maintained and intended as habitat for natural enemies
- The weeds are easier to control on their earlier growing period. Do weeding 4-5 weeks after sowing.
- If possible, do not let the weeds to flower: Remove them from the field before they start to flower.
- The weeds can be removed through hilling-up the furrows with a plow, hoeing, mowing, or cutting.
- The presence of weeds can negatively influence sesame yields. The major factor influencing sesame yield in a competitive situation is the ratio between the relative leaf area of the weed and the crop at the time of crop canopy closure.

There are different options available to control weeds; the choice of weed control method depends on the level of weeds as well as the cost. They include mostly hand weeding and chemical weed control mode:

Hand weeding:

- Hand weeding begins as soon as the weed appears.
- Hoe weeding 3 and 8 weeks after planting is recommended. Hoe weeding should be done 3 and 8 weeks after planting.

Chemical weed control

- The control of weeds is the most important part of sesame production (Grichar et al, 2011). The effects of weeds on sesame establishment and growth have

been well-documented. Herbicides are available that can help control weeds during the production of sesame:

- Use of pre-emergence herbicide: *Pendimentalin* 3-4 liters/ha (e.g. *Stomp*)
- Use of post-emergence herbicide: *Glyphosate* 3-4 liters/ha (e.g. *Roundup, Sarosate,* or *Fitscosate*)

Note: if you have used a chemical at the on-set of farming season in clearing, please do not use again in between the season to avoid killing the entire crop cultivated.

Some hints on the best approach to chemical weed control

- After weed emergence & before the crop emerges: contact/systemic – non selective herbicide.
- Before the weed emerges and before the crop emerges: selective contact/systemic herbicide.
- Avoid chemical weed control when weed emerges and crop emerges (use shield guard and control spraying.

a. Pre-emergence

- The crop protection product should be applied before weeds and crops emerge or sprout.
- The crop protection product kills weeds and not growing plants. Example is *Pendimentalin* (3-4 liters/ha). It should be applied a day after planting.

b. Post-emergence

- The crop protection product is applied on growing weeds.
- It could be selective when it kills weeds and spares crops and non-selective when it kills any green material – be it weed or crop.

3.2. Insect Pests

Sesame is generally free from serious insect pests, but some insects can cause economic damages.

- Mainly, sesame leaf damage insects, such as Heliothis caterpillars, Helicoverpa punctigera and H. armigera and green vegetable bug (Nezara viridula) are known to cause serious problems in Nigeria.

- Heliothis caterpillars are highly mobile and can rapidly damage sesame capsules.

- Termites and Hilda partuelis are encountered and know to causes damages.

Regular monitoring and the application of integrated pest management strategies are essential to minimise deleterious impacts. A high proportion of these is highly toxic and has immediate adverse effects on human health, wildlife, local food sources such as cattle or fish, beneficial insects and biodiversity.

Control of insect pests

- No control measure has proved effective against termites and Hilda partuelis. It is therefore important to avoid growing sesame in fields with a history of termites or in fields with termite mounds.
- Hilda is commonly found at the edge of the field, so its incidence can be reduced by clearing grass at the edges of the field.
- Aphids can be controlled with insecticide sprays but these are expensive, and their usage should be strictly controlled to avoid susceptible adverse effects to humans. Sowing at optimum plant population will restrict aphid movement, thus reducing their damages to plants.

(Bissdorf, J.K., 2007).

- Control is made difficult by the high levels of pesticide resistance found in Heliothis. Insects could be a problem for sesame by serving as disease vectors.
- Insecticides are available for sesame, but should be applied only after scouting. In most instances, there is probably not an economic benefit from spraying.
- Some of them have chronic effects including cancers, reproductive problems, birth defects, hormonal disruption and damage to the immune system. Impacts come from direct exposure in use, spray drift, washing work clothes used while spraying, home pesticide storage, pesticide dumps, and persistence in the environment

Note: Similar pest management strategies to those used for cotton are recommended.

3.3. Diseases

The greatest threat seems from the soil pathogens that can attack and kill seedlings in wet conditions, creating the damping off symptoms. Sesame is prone to root and stem diseases associated with waterlogging, while damping-off diseases can also occur if humidity is high.

Fungal infestation of sesame/aflatoxin contamination

Aflatoxin (*Aspergillus flavus*), a fungi of the Aspergillus group, can invade sesame, producing toxic compounds known as aflatoxins (B_1 B_2 and G_1 G_2).

- Contaminated produce can be poisonous to people and livestock, and cannot be exported.
- Aflatoxin contamination and the related root disease also affect sesame seed, leading to low germination percentage and poor seedling establishment.

- Aflatoxin contamination can occur in the field, before harvest, during harvesting and post-harvest handling processes, e.g. field sun-drying, storage, and transportation of product.

Note: The soil in the field is known to be an excellent storage medium for aflatoxin-producing fungi, e.g. *Aspergillus* species

- Pre-harvest contamination is influenced by soil moisture and temperature, and is likely to be most serious under drought conditions.
- Postharvest aflatoxin contamination occurs if the seeds becomes moist and/or damaged, and can occur at harvest or later.

***The Methods to control aflatoxin contamination*:**

- Avoiding mechanical damage to pods or seeds during weeding, harvesting and storage;
- Harvesting sesame seeds as soon as they are mature;
- Proper drying (until moisture content is reduced to about 10 %; This will help avoid *Aspergillus* infestation and consequent aflatoxin contamination. Normally this can be achieved by sun-drying of pods, and avoiding seeds exposure to rains;
- Storing dry seeds under moisture-free conditions. Moist sesame seeds are prone to fungal diseases, as mold spores are present in all crops.

Note: C*rop* rotation with sesame can help avoid disease problems that could eventually develop.

4. Sesame Production Requirements: Season Activities

Chapter 4 - Sesame Production Requirements: Season Activities

4.1. Sesame Planting

Planting sesame is the most critical phase of its management. Successful establishment of sesame requires careful seedbed preparation and close attention to soil moisture. Sesame grows best on well-drained soils of moderate fertility. The optimum pH for growth ranges from 5.4 to 6.7.

- Good drainage is crucial, as sesame is very susceptible to short periods of waterlogging.
- Sesame is intolerant of very acidic or saline soils.

The response of sesame to both temperature and day-length indicates that it is well adapted to wet season production in the tropics, or summer production in the warmer temperate areas.

Seed Rate

- 4 kg/ha by seed drilling on flat land
- 5 kg/ha on ridges

Planting Date

The crop can be grown twice as an early or late crop, or once a year depending on the ecological zone.

Planting date is linked to rainfall distribution in the area and length of the crop season. Soil moisture must be sufficient to guarantee good germination.

- **In derived savanna** (e.g. Benue, Taraba, and Nassarawa states):
  - the early crop is sown at the onset of rain (March/April)
  - the late crop is sown two months before the end of rains (mid July to early August).
  - **In Southern Guinea savanna** (Niger, southern Kaduna states) and Northern Guinea savanna (e.g. Kaduna, southern Bauchi/Kano/Katsina & Zamfara states):

- late June is the best planting date.

- **In Sudan savanna** (Kebbi, Sokoto, Jigawa states, northern Bauchi/Kano/Katsina and Zamfara states):
  - Planting is by late June to the first week of July.

Sowing

Seed selection and treatment:

Before sowing, seeds should be carefully prepared.

- Sesame seeds for sowing should be sorted in order to eliminate immature, moldy, small seeds and unwanted foreign matters.
- Seeds are then treated with an insecticide/fungicide mixture to control seedling blights caused by soil bacteria and fungi. The fungicide will control soil pests that damage seedlings.
- 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.
- In general early sowing improves yields (significant delay in sowing can reduce yield by 50%) and seed quality.
- Sow the seeds after rain or wet the soil prior to sowing. The seeds to germinate need adequate moisture in the soil for around 3 days. Never sow the seeds on dry soil, always wait for rain or irrigation water.
- Sow 25-35 seeds/ft when planting in well prepared soil with good moisture
- Sow 30-40 seeds/ft when planting on soil that is deep, compact, and cloddy; in cooler temperatures, in less than good moisture; and in fields with hills and low spots

Note:

- Sesame seeds are very small and for them to emerge, they push together the soil.
- Planting less seed/ft usually ends up in missing plants

In most situations, sesame plant adjusts to the population density in a given area. If the population is too high, it will self-thin itself, wherein in a low population, it will develop more branches to fill the spaces.

Spacing (when planting in rows)

There are various options for planting sesame from which farmers can choose. The choice for each farmer will depend on farm size and if the crop is grown sole or mixed with another crop.

- The recommended practice for a sole crop of sesame is to plant on a "flat bed" with 60 cm between rows and 10 cm within rows. Planting on flat by seed drilling makes the operation very easy and could be used in relatively large farms. The spacing between plants will ensure vigorous growth and high yield.

- Planting on ridges with 75 cm between rows and 15 cm within rows can be adopted when sesame is intercropped with another crop. This is usually carried out on smaller farms.

4.2. Thinning

- When the plants attain height of 10-15 cm, remove the weak and diseased plants. It is important to achieve 22plants/meter in order to attain a high yield.

Try to maintain the plant population of 222,000 plants/ha to attain the maximum yield.

5. Plant Development and Recommended Practices: Seasons Practices

5.1. Maturity and Harvest Determination

The Sesame development is sequenced into several development stage, starting from the day after planting (DAP) to the harvest stage

5.1.1. Planting Stage end point **DAP: 0 - 5 -** Emergence

5.1.2. Seedling Stage end Point DAP 6 – 25: *3rd pair true leaf length*

- The seedling stage is a tough time for producers because of slow pace of growth
- This stage is difficult to cultivate
- The stage ends when the 3rd pair of leaves is as long as the 2nd pair.
- First fertilizer application (NPK 4 bags/hectare)

5.1.3. Juvenile Stage end Point DAP 26 - 37: *First buds*

- Dramatic surge of growth
- Important stage to consider beginning cultivation, side dressing, directed herbicides
- The stage ends when first green buds are visible

5.1.4. Pre-Reproductive Stage end Point - DAP 38-44: *50% open flowers*

- Most important farming stage to optimize the production
- Last chance to side dress, let alone; get a tractor into the field
- From this stage till late bloom, it is important to minimize stress to the crop
- Optimum stage to apply Fertilizer

- When the plants attain 10-15 cm height remove the weak and diseased plants
- It is important to achieve 22plants/m to attain a high yield
- Tray to maintain the plant population of 222,000 plants/ha to attain the maximum yield

- **Note:** Apply fertilizer after this stage may delay harvest without a commensurate return on investment.
- This stage ends when there are open flowers on 50% of the plants

5.1.5. Early bloom stage end points DAP 45-52:

5 node pairs of capsules

- In the Early bloom stage, in most cases, the early flowers will not make capsules.

  In sesame it is normal for the white portion (corolla) of the flower to drop off the plant in the evening

- The part of the flower that makes the capsule will remain on the plant.

- This stage ends then there are 5 pairs of capsule nodes

5.1.6. Mid-Bloom Stage End Point - DAP 53-70:

Branches/minor plants stop flowering

- Most productive stage (because the main stem and branches are putting on capsules.
  - Even though the plants flower at 5-6 weeks, 70-75% of flowers appear on the 2nd and week of flowering.
  - Plants are pulling deep moisture (from as deep as the plant is tall of deeper)
- The lower leaves that are shed will drop.
- This stage ends when the branches and minor plants stop flowering

5.1.7. Late Bloom Stage end Point - DAP 71-80 –

90% of plants with no flowers

- This is the time to compare fields to make harvesting plans:
  - The field that ends the late bloom stage first will most likely be the first to harvest even if it wasn't plant first.
  - Differences in fertility and rainfall of irrigation influence the end of this stage.
- This stage ends when 90% of the plant have no open white flowers

5.1.8. Ripening Stage end Point DAP 81-90:

Physiological maturity (PM)

- This phase is not divided into stages and technically, it starts during the reproductive phase when the first capsule is formed.
- Most of the leaves fall of the plants. Generally, leave will turn yellowish-green before falling.
  - **Note:** The leaves that drop due to drought are not considered self-defoliation by maturity.

- This stage ends when 75% of the capsules on the main stem have seed with final color and a dark tip. The seed will also have dark seed line on one side. PM is important at that point, the crop is less susceptible to yield loss.

- It is also an indicator that the time to use harvest aids is approaching.

- Late dry down stage is the final stage we have been waiting for.

- The stage ends when the seeds have 12% moisture and can be harvested.

- Harvest commences as soon as the leaves fell away.
- **Note:** Most critical period as an inexperience farmer can lose most seed through shattering.

6. Harvesting and Post-harvest Handling Practices

6.1. Harvesting Sesame Seed

Specific recommendations are developed mainly to reduce seed losses during harvesting and improve the quality grade of products.

The indeterminate growth habit of sesame with its subsequent uneven ripening of the capsules creates difficulties for mechanical harvesting.

It is important that the crop be completely dry before harvesting, as sap from green material passing through the header can discolour and taint the seed, creating off-flavours in subsequent processed products.

When to Harvest?

- The harvesting starts when 75% of the fruit capsules are ripened e.g. have turned brown.

- the crop dries above where it will be cut,
- stems tend to change from green to yellow to red in color and
- the leaves will begin to fall off.

Chapter 6 - Harvesting and Post-harvest Handling Practices

- Physiological maturity normally occurs 90 - 110 days after planting and normally dries down in 130 - 160 days, depending on variety and climatic condition.
- Sesame is usually mature for harvesting between 90 and 130 days after planting (DAP).
- Harvesting is done when many leaves have dropped off, and most of the remaining ones have turned yellow and the lowest capsules on the stem are about to split open.
- When the plants are sufficiently dry the bundles are threshed on a tarpaulin spread on the ground. The plants are beaten gently with sticks and seeds are collected, winnowed and bagged for storage or sale.

- Make bundles and stalked upright for drying.
- One week after harvesting, thrash and winnow the seeds.

- To avoid contamination and reduce losses, thresh on a tarpaulin or clean concrete floor.

Note: This is extremely important as some buyers will reject sesame that has been contaminated with fungal infestation that causes food poisoning, e.g. aflatoxin contamination.

- This refers even more to the white seeded varieties as they are directly used for human consumption, while the light brown seeded varieties are processed further (oil).

- The plants are cut with a cutlass or sickle and should be immediately bundled, tied upright and left in the sun for one week or until they are sufficiently dry for threshing.
- Delays in harvesting should be avoided to prevent seed loss through shattering
- Time of harvesting depends on the variety.
- Harvest as soon as the crop matures (e.g. from late October to December. If harvesting is delayed, shattering of the capsules will result in seed loss.
- Avoid contamination during harvest.
- Do not harvest by uprooting to avoid contamination but harvest by cutting the plants with a sickle or knife.

6.2. Manual harvesting

- The harvesting starts when 75% of the fruit capsules are ripened.
- While harvesting, it is better to cut than pull in order to avoid impurities:
  - The crop dries above where it will be cut stems tend to change from green to yellow to red in color and the leaves begin to fall off.
  - Physiological maturity occurs 80-90 days after planting (DAP) and normally, dries down in DAP 95-100, depending on variety and climatic conditions.

6.2.1. Threshing and Winnowing

- **Work on tarpaulin** (to avoid soil contamination)

- For storage, the seeds must have 10% moisture content.
- Sesame seeds need to be threshed without further contact with soil.
- Winnow sesame seeds avoid contamination with soil, and any kind of source of humidity.

6.2.2. Drying

Note: Sesame seed small scale pprocessing are recommended from farm gate

The primary objective of drying is to achieve rapid but steady drying of the pods, in order to avoid aflatoxin contamination.

- Harvested plants should be staked in the field for a few days to allow them to dry in the sun and air, before stripping the pods.

- Then drying should continue until the moisture content is reduced to 10%. Normally this can be achieved by drying the pods in the sun for 6-7 days, taking care to cover them if it rains:
  - A too long exposure of the pods to the sun could affect both seed quality and seed germination.

- Sesame seed is easily threshed and relatively delicate, so drum speed should be reduced to about half of that required for cereals, and the concave clearance made as wide as possible.

- Seed damage during harvesting affects both the viability of the seed, storage and the quality of the oil.

- Since sesame is a small flat seed, it is difficult to move much air through it in a storage bin. Therefore, it is recommended that the seed be harvested as dry as possible, and stored at moisture of about 6%.

- More importantly, during oil processing, moist seed leads to low yields and clogs the screw or cage, a part of the press.

- Moist seed are prone to fungal infestation, as mold spores are present in all crops. A rule of thumb is that the moisture content of the seed should be close to 10 percent (Kurki et al. 2008).

- Excessive moisture of seeds can quickly heat up and become rancid.

- Freshly harvested seed above 6% should not be left sitting on a truck for long to avoid spoilage.

- Idle trucks with sesame on board should generally not be tarped on a sunny day, since the tarp can increase heat buildup.

- Sesame grain is sold on a weight basis rather than a bushel basis.

6.2.3. Storage

Sesame seed is best stored unshelled, in dry conditions, protected from rain and vermin (particularly rats and mice). The seeds for storage must have 10 % moisture content:

- Bagged seeds (whether shelled or unshelled) should not be placed directly on a concrete floor due to the risk of dampness that may cause mould to develop.

- Before bagging, dust the pods with Actellic Super to protect them from storage pests.

  - For short term storage of less than six months, store grains in a clean and roofed store.
  - Lock up the store for safety.
  - Sesame can be stored – if kept in a cool place - for approximately 5 years without loss of viability

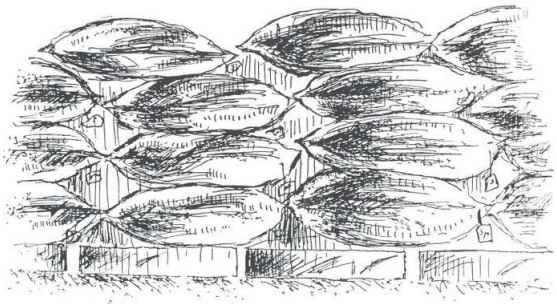
Note: For safe long-term storage, sesame seed should be clean, have moisture content no more than 6% and be stored at a relative humidity of approximately 50% and at cool temperature..

6.2.4. Transportation

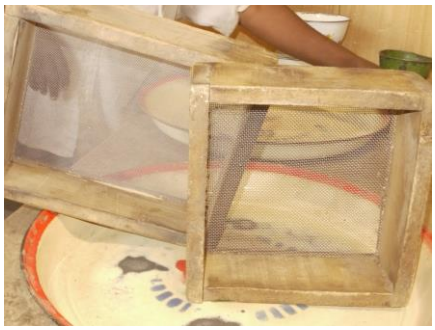
Bulking and Delivery

- Bulk grains and bag immediately after threshing. Drying for about 2-3 more days under direct sunlight is necessary to prevent spoilage.
- Stack bags on pallets to improve aeration.
- Tag bags and transport bags to designated collection centers.
- Weigh bags in designated collection centers and record weight in ledgers.

- Transport weighed grains to larger collection centers.



6.3. Manual Cleaning process



6.4. Mechanical Cleaning








6.5. Sesame Seed Quality Control

For consumer safety reasons, the Quality Assurance standards should reflect a meticulous and thorough testing process that adheres to stringent guidelines at every step of the sample handling processes from

6.5.1. Quality Assurance:

Raw Material Evaluation/Testing:

- To help ensure that only fresh, potent, and pure ingredients are used - yielding premium supplements that are unsurpassed in quality.
- Quality assurance measures are required from the sesame production stage, all throughout sample processing stages, during sample storage, and within post-harvest handling facilities.

6.5.2. Quality Control (QC):

- Post-harvesting operations include series of measurements of elements such as moisture, oil contents and facility environments that are constantly monitored to ensure comprehensive quality storage, manufacturing and post-harvest handling compliance.
- In addition, ensuring proper packaging of sesame seeds to ensure product integrity, purity and label claim accuracy is more and more priced. .

- QC Laboratory should employ qualified chemists and microbiologists who test raw materials and finished products to ensure that they meet our rigorous specifications for consistency and quality of product.

  Where appropriate, QC procedures confirm that a finished supplement meets or exceeds our high quality standards.

- **In-house testing and control procedures are required to verify and ascertain everything, e.g., the quality of raw materials from the field to post-harvest handling stage. At this stage, the quality control tests are performed on seed samples withdraw de from bulky delivery and/or from packed in badged samples**.

- The main quality control tests performed *in situ* include:
  - Measurement of % moisture content
  - Measurement of % oil content
  - Visual assessment of seeds:
    - To eliminate foreign matters
    - Discard of Moldy seeds,

- The microbial purity tests essentially meant for the evaluation of:
  - fungal infestation (for Aflatoxin contents), and
  - the bacterial burdens, are performed extemporary.

- Further in-depth control:
  The Products should undergo stringent testing before, during and post-harvest handling steps, using recognized techniques including analysis by High Performance Liquid Chromatography (HPLC), Gas Chromatography (GC), Fourier Transform Infrared Spectroscopy, Thin Layer Chromatography (TLC), Ultraviolet/ Spectrophotometry, etc.

- Quality Assurance team of the processing plant and Quality Control State Departments should work in concert, providing checks and balances that ensure attention to a supplement's finest details, from raw material testing to final product analysis.

- Owing to continuous improvement purposes, at every stage in the field, and sesame post-harvest handling and during manufacturing process, samples control procedures, and standards must be reviewed and approved by QA professionals.

6.5.3. Certification of services/products:

For services/products certification purposes, sesame products are expected to meet the quality and safety requirements of the most rigorous independent inspection and certification programs.

REFERENCES

1. W. James Grichar, Peter A. Dotray and D. Ray Langham (2011). Weed Control and the Use of Herbicides in Sesame Production, Herbicides, Theory and Applications, M. Larramendy (Ed.), ISBN: 978-953-307-975-2.
2. CAC (2003): Code of Practice for the …… CAC/RCP 51-2003
3. Al Kurki, J. Bachmann, H. Hill, L. Ruffin, B. Lyons, M. Rudolf (2008): Oilseed Processing for Small-Scale Producers; ATTRA - National Sustainable Agriculture Information Service; NCAT.pp-1-16.
4. USAID-MARKETS (2009): Package of Practices for Sesame Production.
5. BR Ntare AT Diallo, J Ndjeunga and F Waliyar (2008). Groundnut Seed production Manual. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). 20 pp.

PHOTOS:

- **Cover Page:** B. Doko -
- **Page 6 :** B. Doko -
- **Page 9 :** B. Doko -
- **Page 11:** B. Doko -
- **Page 15: Source:** httpcorn.agronomy.wisc.eduManagementimagesL007FieldCultivator2.jpg
- **Page 19**: A woman weeds a sesame crop field in South Sudan's Eastern Equatoria state.

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TABLES

Table 1: Basic characteristics of released sesame varieties [by the National Cereals Research Institute (NCRI), Badeggi, Nigeria].

Variety	Days to Maturity	Characteristics of Seed		% Oil content	Potential yield (kg/ha)
		color	Size		
NCRIBEN-01M	102-115	White	3	45	1000
NCRIBEN-02M	102-115	Light brown	3	45	750
NCRIBEN-03M	125-140	White	2	40	600
E8	90	Light brown	3.6	50	1000
Yandev 55	125	Light brown	2.5	45	600

Table 2: the type of sesame seed produced and their growing location in Nigeria

Sesame quality grade	The Sector of usage	Location	
		State	Place/town
White/raw (food grade)	bakery industry	Benue state	Makurdi
		Taraba state	
		Nassarawa state	Keffi, Lafia, Doma
Brown Mixed (oil-grade)	Oil industry	Kano state	
		Jigawa state	Hadejia
		Katsina State	