

SOYBEAN PRODUCTION TRAINING GUIDE



INTRODUCTION

Soybean is an important food crop in the sub-Saharan Africa, especially in the savanna regions of West, East and Southern Africa. The seeds are a major source of plant proteins and vitamins for man, feed for animals, and also a source of cash income.

There is a big market for the sale of Soybean grain and fodder in West Africa. In Nigeria for example, farmers who cut and store soybean fodder for sale at the peak of dry season have been found to increase their annual income by 25%. Soybean also plays an important role in providing soil nitrogen to cereal crops (such as maize, millet and sorghum) when grown in rotation, especially in areas where poor soil fertility is a problem. Soybean does not require a high rate of nitrogen fertilization; its roots have nodules in which soil bacteria called Rhizobia help to fix nitrogen from the air.

This guide draws its lessons from the work and experience of IITA and partners in Research for Development (R4D) on soybean-based systems in West Africa.

CLIMATIC AND SOIL REQUIREMENTS

Soybean can be grown under rain-fed conditions as well as by using irrigation or residual moisture along river or lake flood plains during the dry season, provided that the range of minimum and maximum temperatures is between 28 and 30°C (night and day) during the growing season. Soybean performs well in agro-ecological zones where the rainfall range is between 500 and 1200 mm per year. However, with the development of early maturing soybean varieties, the crop can

thrive in areas where the rainfall is less than 500mm per year. It is well adapted to sandy and poor soils. However, best yields are obtained in well-drained sandy loam to clay loam soils with the PH between 6 and 7.

Proven Soybean Production Technologies for dissemination

- Climate-smart Soybean Varieties :
TGx 1444-2E, TGx 1951-3F and TGx 1904-6F.
- Good Agronomic Practices.
- Double density Technology, Seed rate estimation
- Inoculant (NoduMax) usage technology + SSP Fertilization
- Home level Soybean Processing Technology for Value added products-e.g. milk, flour & **SOYA OIL EXTRACTION**

Good agronomic practices (GAPs): GAPs, as defined by FAO, are a “collection of principles to apply for on-farm production and postproduction processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability.”

Food safety has gained increasing importance over the years because of its significance both from health and trade perspectives. The production of safe food is essential for protecting consumers from the hazards of foodborne illnesses. It is important both in the domestic food business as well as for increasing competitiveness in export markets. Hazards may occur at different stages of the food chain starting right from the primary production, e.g. residues above permitted levels, microbial contaminants and heavy metals. It therefore becomes important to address food safety right from food production at farm level. Implementing Good Agricultural Practices (GAPs) during on-farm production and post-production processes resulting in safe agricultural products is of immense importance for ensuring a safe food supply. Many importing countries as well as domestic buyers, especially organized retailers, do require producers to implement GAP as a prerequisite for procurement to ensure the quality and safety of their produce.

In addition, implementing GAPs also helps promote sustainable agriculture and contributes to meeting national and international environmental and social developmental objectives. It has been documented that implementation of GAP encourages promotion of the optimum use of resources such as pesticides, fertilizers, and water, and eco-friendly agriculture. Its social dimension would be to protect the health of agricultural workers from improper use of chemicals and pesticides.

GAPs cover a range of options that are essential to higher productivity and greater efficiency, and ones that are often overlooked. Direct seeding systems without extensive soil tillage for example can save significant labour on land preparation, preferentially benefitting women.

Crop residue retention, often dependent on the availability of biomass and the intensity of crop-livestock interaction, provide approximately 70% of the benefits and will usually add benefits to farmers' fields when retained as mulch.

The age-old practice of crop rotation is crucial to suppress pests and diseases, increase soil fertility, add to diversification to reduce risk and improve food and nutritional security in the farming system.

Green manure cover crops (GMCCs) are used to cope with declining soil fertility and the unavailability of cash to buy external inputs such as mineral fertilizers. In the past five years there is increasing interest by farmers and development partners to also provide alternative feed for livestock.

CRITICAL STEPS IN SOYBEAN CULTIVATION.

Site selection

Proper site selection is very important. Select a well- drained sandy loam soil for rain-fed soybean, or inland depressions and along the shores of a lake for dry season soybean using residual moisture. Soybean does not tolerate excessively wet conditions or water logging and should not be grown on poorly drained soil.

Choice of Soybean varieties

Select a variety suited to your agro-ecological zone, based on suitability for the prevalent climatic conditions and cropping systems. The choice of variety should be based on maturity period, yield potential, drought tolerance, responsiveness to day length and pest and disease resistance. Table 1 shows some of important issues to consider when selecting a soybean variety for a particular environment. The color and size of the seeds are very important to consumers and farmers. Seed size in particular determines soybean storability to reasonable extent.

TABLE 1.VARIETIES RECENTLY RELEASED FOR CULTIVATION IN NIGERIA

Resilient Varieties	Seed Yield MT/ha	Maturity	Diseases resistance	Description
TGx 1987-10F	1.5-2.0	Early	R	Highly promiscuous
TGx 1987-62F	1.5-2.0	medium	R	Good Nodulation, Rust and resistant to cercospora leaf spot.
TGx 1951-3F	1.5-2.0	Early	R	Good Nodulation, Rust and cercospora leaf spot resistance
TGx 1448-2E	1.3-1.8	medium	Moderate	Highly promiscuous but susceptible to Rust
TGx 1904-6F	1.2-2.0	Early	R	Good Nodulation, Rust and resistant to cercospora leaf spot.

Soybean-Cereal Intercropping

Where soybean is to be intercropped or relayed with other crops, such as maize, the spacing should be 75cm x 5cm (shown above). Also the soybean should be planted at about 3-4 weeks after planting the first crop, maize, sorghum, or millet. For strip intercropping, adopt 2 rows of cereal to 4 rows of soybean to improve the productivity of soybean varieties.

The cereal and soybean should be planted at the recommended spacing.



Soybean intercropped with Maize for nutrient recycling.

FERTILIZER RATE AND APPLICATION.

Soybean does not require too much nitrogen fertilizer because it fixes its own nitrogen from the air using the nodules in its roots. However, in areas where soils are poor in nitrogen, there is a need to apply a small quantity of about 15kg as a starter dose for a good crop. If too much nitrogen fertilizer is used, the plant will grow luxuriantly with poor grain yield.

Soybean requires more phosphorus than nitrogen in the form of single super phosphate (SSP). About 30kg of P/ha in the form of SUPA is recommended for soybean production to help the crop to nodulate well and fix its own nitrogen from the air.



Soybean with Nodules for N fixation at flowering stage.

RECOMMENDED FERTILIZER RATE FOR SOYBEAN PRODUCTION

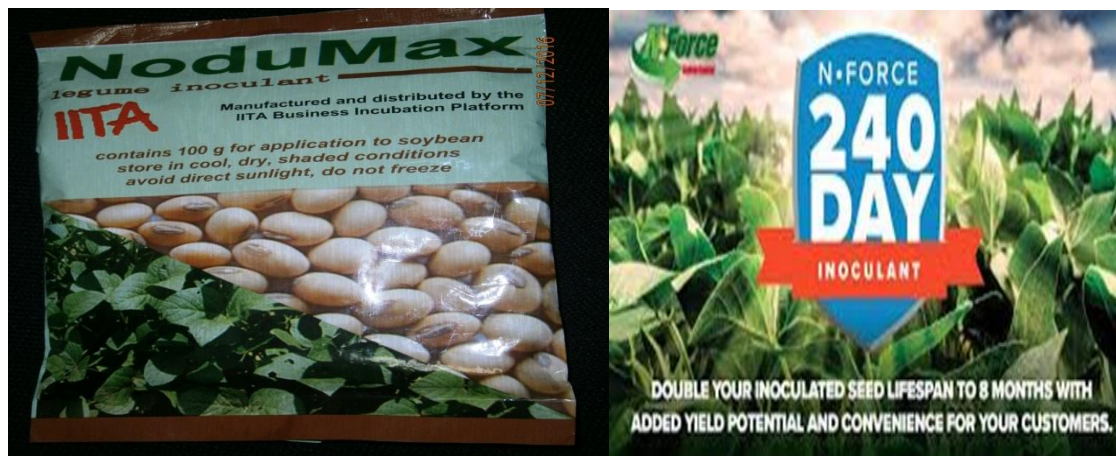
Fertilizer nutrient/ha	Quantity equivalent in bags/ha	Time of application	Remarks
15kg N	2 bags of compound fertilizer (NPK 15:15:15) particularly in soils that had been severally cultivated.	Apply during land preparation or at planting by incorporating into the soil	This will supply 15kg each of nitrogen, phosphorus and potassium.

Legume inoculants--- NoduMax Technology

NoduMax is a new technology that increases the yield of soybean up to 30% particularly when it is properly adopted by potential soybean farmers.

A sachet of NoduMax (about 100 g for application to soybean) is guaranteed to contain at least 1 billion live soybean rhizobia per gram. About 5 sachets of NoduMax will be needed to plant one hectare of soybean field.

NOTE- NoduMax should be stored in cool, dry, shaded conditions. Avoid direct sunlight, do not freeze.



Inoculants for Enhanced Soybean Yield.

USERS' INSTRUCTIONS FOR NODUMAX

Prepare sticker: Dissolve contents of enclosed gum Arabic packet into 300 ml of warm water.

Spread seed: Add 10 to 15 kg of soybean seeds to a large basin.

Apply sticker: Add sticker to seeds and mix until uniformly coated.

Apply inoculants: Add 100 g of NoduMax to about 10-15 kg of soybean seeds and mix until seeds are uniformly covered with the inoculants.

Allow to set: Cover the inoculated seeds with a cloth and allow the sticker to set for 10 minutes. Avoid direct sunlight.

Plant seeds: Plant the inoculated soybean seeds as soon as possible into a moist seed bed.

LAND PREPARATION

Clear the site of shrubs and stubble. Alternatively, spray the field with Glyphosate (Round-up) at the rate of 4 L/ha (about 2 1/3 milk tins of chemical in a 15-L sprayer or 3 milk tin of chemical in a 20-L knapsack sprayer) to kill emerged weeds. Land can also be prepared manually with the African hand-hoe. Plow and harrow the field to provide sufficient soil pulverization for good root growth.

Make ridges thereafter if desired. Where the soils are more fragile and prone to erosion, adopt minimum or zero tillage.

SEED REQUIREMENT

Use about 50-60 kg/ha of soybean seeds, depending on the variety, seed size, cropping system and viability of the seeds.



Mechanized Land Preparation in readiness for planting.

PRE-SOWING SEED DRESSING.

Treat seeds before sowing with Benomyl (50%) or Carbendazine, Captan or Thiram at the rate of 3 g/kg (1 sachet) of seeds or with Apron plus at the rate of 10 g/4-5 kg of seeds (1 sachet) or Apron star 42 WS at the rate of 10 g/8kg of seeds/1 sachet. This will enhance good germination and protect the seedlings from fungal infection soon after emergence.

However, the use of fungicides may not be necessary particularly when inoculants are employed.

PLANTING OPERATIONS:

When establishing a soybean farm, do not plant too early so that the crop does not mature during the rains. Also do not plants too late to avoid the danger of an early end to the rains.

It is critical to determine the onset and duration of the rains and more importantly, the maturity period of the soybean variety before planting. This will guide you on when to establish your soybean farm.

SOWING AND SPACING IN SOYBEAN SOLE CROPPING

Erect soybean varieties should be planted at a spacing of 60cm between rows and 5cm within rows, especially for early maturing varieties (90-100 days). For medium maturing varieties, spacing should be 50-60cm between rows and 5cm within rows.

Soybean should be planted either on ridges or on flat beds, depending upon the field preparation. Planting is usually manual by drilling. However, **mechanical planters are now readily available particularly when large hectares are to be planted.**

SOWING DEPTH

Sow seeds at a depth of 2.5 to 5cm for most varieties.

Planting seeds more than 5cm deep will delay emergence. The seeds may rot and plant stand will be uneven.



Drilling sowing method in sole soybean cultivation.



Ensuring the Right within-row spacing for optimum Soybean plant population.



Soybean plants in sole cropping.





Soybean plants in sole cropping.

WEED CONTROL

Weeds are serious problem in soybean production, and if not well managed, can harbor pests and reduce both the yield and quality of the grain. Fodder yield can also be reduced. Soybean is not a strong competitor with weed, especially at the early stage of growth. The type of weed control measures adopted should be based on the nature of the problem and the resources available to the farmer. Weed control in soybean could be during pre-planting using either manual or chemical methods.

Pre-planting weeds control/zero tillage.

Chemical weed control

Herbicides, if used properly, are safe and effective in controlling weeds in soybean. The choice of herbicide however depends on the predominant weed species and the availability of the herbicide. If herbicide is used at planting, one hoe weeding may be required at 4-5 weeks after planting. Application of a tank mixture of paraquat and pendimethalin within 2 days of planting is recommended. Paraquat controls emerged grass and broadleaf weeds while pendimethalin prevents weed seeds from germinating. Do not apply herbicides that are not recommended to soybean to avoid damage to the plant.

Spray with Glyphosate where there are troublesome weeds such as sedges and spear grass or when minimum/zero tillage practices are desired. Glyphosate kills the weeds right from the roots and thus allows the farmers to prepare the field or plant the crops without the fear of the troublesome weeds emerging within the same season. Glyphosate is marketed in different brand names such as Glycel, Force Up, Round Up, Delsate, Uproot, Sarosate, Touchdown, Clearweed, Killoff, Bushfire, etc.

USE OF SELECTIVE HERBICIDES

A number of selective herbicides of Chinese origin are now available. Such herbicides are applied at about 2-3 weeks after planting. With close spacing with subsequent rapid canopy formation, manual weeding may not be necessary during the entire cycle of the plant in the field.

Examples are HAIMEBA from Chinese Hangzhou Agro-chemical limited <hangzhou@163.com> and IRRI. Fusilade forte is an old post-emergence herbicide

Manual weed control

Manual weed control is the most common method used by farmers in soybean production. Weed your soybean fields trice with the hoe, first at 2 weeks after planting, second at 4-5 weeks after planting and third 7-8 weeks to ensure a clean field. Poor weed control or delay in weeding causes drastic reduction in yield.

SOYBEAN DISEASES AND THEIR CONTROL

Fungal, bacterial and viral diseases affect soybean. Different diseases affect different parts of the crop at different stages of growth. The major and common diseases are bacterial pustule, rust, soybean mosaic virus, frog eye leaf spot.

Control measures include:

- Adopt crop rotation.
- Use clean seeds.
- Dress seeds before planting (Apron Star).
- Use a resistant varieties.
- Uproot and bury infected plants.
- Plow contaminated topsoil to reduce the incidence of pathogens.
- Apply fungicide (Benomyl or Mancozeb) to leaves at the rate of one small matchbox-full in a 15-L sprayer.

Insect pests and control:

Insect pests are not a major problem in soybean production. However, leaf beetles and pod sucking bugs might show up in certain environments.

Generally, 1-2 sprays with insecticides may be required for a good crop of soybean, depending on the severity of insect attack.



Soybean at Physiological Maturity and Harvest Maturity Stages.

HARVESTING

Harvest soybean when the pods are fully mature and dry and the plants have fully shed their leaves. Do not harvest soybean by hand pulling because this may remove the roots that contain nitrogen and contribute to soil fertility. Instead, cut the mature plants at ground level using a cutlass or sickles. Make sure grain of different varieties is not mixed. Mixed grains lower the market value.

After harvest, heap up the harvested plants and thresh the soybean pods manually by gently beating the pods with a stick on a raised, clean, and dry platform or a floor with a large tarpaulin. For a large soybean field, the use of a thresher can be adopted.

Dry the threshed grains on mats, plastic sheets or other clean surface for two sunny days; protect from rain and animals. Test the grain to see if it is dry enough by biting or pinching grain with your fingernails. Grains should break or crack, not bend or stick between your teeth or fingernails.



Harvested soybean heaped for threshing

Harvested soybean plants are heaped up on a platform. Threshing can be done by beating dried plants with a long stick. Clean the seeds and separate them from chaff or haulms through winnowing.



Figure 4: Motorized thresher for soybean



Motorized thresher in operation.



The use of a Combine provides the best soybean harvest and Processing.



Clean soybean seeds ready for storage.

POSTHARVEST PROCESSING AND STORAGE

Clean out the store thoroughly before a new crop is loaded. Old residues should be burned. Only well-dried and properly cleaned seeds should be stored. A well-dried soybean seed should have 10% moisture content or less. Such seeds make a cracking sound when crushed between the teeth.

It is advisable to store your soybean seeds in water-prove polythene bags so that they can be used as planting materials in a subsequent planting season. Every bag of soybean seed must be stored on raised platform in a cool storage not so much higher than a normal room temperature.

However, grains (soybean seed for consumption) can be stored in jute bags with no harm as these can be left at room temperature for more than a year without any insect attack.

Examples of Soybean Seed storage bags





Hermetic PIC Bags: Bell Industries, Kenya.



Storing Processed Soybean