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Farmers' Guide to Soybean Production in Northern Nigeria

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May 2009

Who we are

Africa has complex problems that plague agriculture and people's lives. We develop agricultural solutions with our partners to tackle hunger and poverty. Our award-winning research for development (R4D) is based on focused, authoritative thinking anchored on the development needs of sub-Saharan Africa. We work with partners in Africa and beyond to reduce producer and consumer risks, enhance crop quality and productivity, and generate wealth from agriculture. IITA is an international non-profit R4D organization established in 1967, governed by a Board of Trustees, and supported primarily by the CGIAR.

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ISBN 978-131-333-1

Printed in Nigeria by IITA

Citation: Dugje, I.Y., L.O. Omoigui, F. Ekeleme, R. Bandyopadhyay, P. Lava Kumar, and A.Y. Kamara. 2009. Farmers' Guide to Soybean Production in Northern Nigeria. International Institute of Tropical Agriculture, Ibadan, Nigeria. 21 pp.

Cover: Soybean production field.

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Introduction

Importance of soybean in the global economy

Soybean is among the major industrial and food crops grown in every continent. The crop can be successfully grown in many states in Nigeria using low agricultural input. Soybean cultivation in Nigeria has expanded as a result of its nutritive and economic importance and diverse domestic usage. It is also a prime source of vegetable oil in the international market. Soybean has an average protein content of 40% and is more protein-rich than any of the common vegetable or animal food sources found in Nigeria. Soybean seeds also contain about 20% oil on a dry matter basis, and this is 85% unsaturated and cholesterol-free.

The rapid growth in the poultry sector in the past five years has also increased demand for soybean meal in Nigeria. It is believed that soybean production will increase as more farmers become aware of the potential of the crop, not only for cash/food but also for soil fertility improvement and *Striga* control. The market for soybean in Nigeria is growing very fast with opportunities for improving the income of farmers. Currently, SALMA Oil Mills in Kano, Grand Cereals in Jos, ECWA Feeds in Jos, AFCOT Oil Seed Processors, Ngurore, Adamawa State, and PS Mandrides in Kano all process soybean.

IITA along with partners has developed improved technologies for soybean production. This handbook outlines crop production practices that farmers may use to grow soybean profitably in Nigeria.

Why grow soybean?

- It is good for food—soy-milk, soy-cheese, *dadawa*, Tom Brown (infant weaning food),
- It is the source of an excellent vegetable oil,
- It is used in industry,
- It improves soil fertility and controls the parasitic weed, *Striga hermonthica,*
- Soybean cake is an excellent livestock feed, especially for poultry,
- The haulms provide good feed for sheep and goats.

Figure 1. Preparing land for soybean production using a tractor.

Conditions necessary for soybean production

Soybean growth is influenced by climate and soil characteristics. Soybean performs well in the southern and northern Guinea savannas of Nigeria where rainfall is more than 700 mm.

However, short-duration varieties can thrive in the much drier Sudan savanna when sown early and with an even distribution of rainfall throughout the growing period. The time for planting soybean depends upon temperature and day length. Soybean is a short-day plant and flowers in response to shortening days. It can be grown on a wide range of soils with pH ranging from 4.5 to 8.5. Soybean should not be planted in sandy, gravelly, or shallow soils to avoid drought stress. It should not be grown in waterlogged soils or soils with surfaces that can crust, as this will lead to poor seedling emergence.

Preparing to plant

Land preparation

Clear all vegetation before land preparation. The seedbed may be prepared manually with a hoe or animal-drawn implement or tractor (Fig. 1). Well-prepared land ensures good germination and reduces weed infestation. You can plant on ridges or on a flat seedbed.

Table 1. Recommended soybean varieties for Guinea savanna ecological zones in Nigeria.

Variety	Ecology	Characteristics	*Striga* control
TGX 1448-2E	Southern and northern Guinea savannas	Medium maturing, high yield, low shattering, high oil content, excellent grain color	Good
TGX 1835-10E	Guinea savanna	Early maturing, rust resistant, pustule resistant	Not known
TGX 1485-1D	Guinea savanna	Early maturing, pustule resistant, rust susceptible	Not known

N.B. Early and extra-early maturing varieties are strongly recommended in the Sudan savanna because of the low amount and duration of rainfall in the zone.

Choice of variety

Selected soybean varieties grown in Nigeria are presented in Table 1. Choose a variety suited to your agroecological zone. Soybean variety selection should be based on maturity, yield potential, lodging, drought tolerance, and resistance to pests and diseases. The maturity period should be the first consideration when choosing a variety suited to your geographical zone. Consider varieties that are earlier maturing rather than late maturing in areas with low rainfall. Although later maturity increases the yield potential, it is risky to grow late-maturing varieties in drier environments because of late-season drought.

Seed cleaning and preparation

Use high quality seeds of the selected variety (Fig. 2). Soybean seeds easily lose their viability. It is common for soybean, even when stored properly, not to germinate after 12 –15 months in storage. Therefore, use seeds that are not more than 12 months old to ensure good germination. Sort out the good seeds for planting to ensure that they are free from insects, disease infestation, and weed seeds. Do not purchase seeds from the open market as the germination potential is not guaranteed. Planting poor quality seeds will not produce a good yield (Fig. 3). Always buy seeds from seed companies or seed producers nearest to you.

Figure 2. Use good seeds for planting.

Figure 3. Do not use poorly sorted seeds.

Soybean germination test

Test seeds for germination before planting. The germination rate should be 85% or more to obtain a good stand. To conduct a quick seed germination test, select 400 seeds randomly and sow 100 seeds each in four wooden or plastic boxes or a prepared seedbed. Sow one seed/hole at a distance of 10 cm between the seeds. Soak cloth- or paper-lined germination boxes or the seedbed well with water before sowing and provide water every morning and evening. Start counting the seedlings 5 days after sowing and complete the counting within 10 days. A total count of 320 germinated seeds or more indicates a germination rate of 80% and above. When the percentage germination is 80% or less, the seed rate has to be increased accordingly to achieve 100% germination.

Planting

Date of planting

Soybean produces well over a wide range of planting dates, if moisture is available. The recommended dates for planting soybean in different ecological zones in Nigeria are presented in Table 2. Do not plant too early

Table 2. Recommended dates for planting soybean in Nigeria.

Ecological zone	Suggested time of planting
Moist savanna/southern Guinea savanna	Early June–early July
Northern Guinea savanna–Sudan savanna	Mid-June–early July
Sudan savanna	July, weeks 1–2

because a prolonged dry spell after planting may result in permanent wilting of the crop and the need for replanting. Late planting, on the other hand, may expose the crop to attack by some late season pests and also deprive the crop of sufficient moisture if the rains stop early. Plant soybean as soon as the rains are well established.

Seed rate

About 50–70 kg (20–28 standard *mudus*) are required to obtain a population of 444,444 plants/ha for soybean varieties. Since soybean seed size varies among varieties, it is essential to consider planting in terms of seeds/unit area. It is not uncommon to see sizes ranging from 12.6 to 18.9 g/100 seeds

Seed dressing

Treat seeds with fungicides, such as Captan, Apron Plus, or Thiram, at the rate of 1 sachet/8 kg of seeds before planting for protection against soil-borne fungal diseases.

Plant spacing and sowing

Sow soybean by hand, planter, or by drilling. Plant 3 to 4 seeds/hole at a spacing of 75 cm between rows and 10 cm between stands. Alternatively, drill seeds at 50–75 cm between rows and 5 cm within rows. For the early maturing varieties, a spacing of 50 cm between rows and 5–10 cm within rows is recommended because they respond better to narrow spacing than the late-maturing varieties. Do not sow seeds more than 2–5 cm deep. Deeper planting may result in loss of vigor or failure of seedlings to emerge.

Figure 4. Soybean in rotation with maize.

Fertilizer

A good fertilizer recommendation for soybean production depends on a good soil test. Under normal conditions, soybean as a legume should provide itself with nitrogen through biological nitrogen fixation. Until nodulation occurs, the soybean plant depends on soil nitrogen for growth. Phosphorus is often the most deficient nutrient, therefore, apply optimum phosphorous fertilizer for good yield. Apply phosphorus at the rate of 30 kg p/ha in the form of single super phosphate fertilizer (SUPA) (3 × 50 kg bags) in addition to 2½ × 50 kg bags of compound fertilizer NPK 15:15:15. Nitrogen and potassium fertilizers are needed only when there are obvious deficiencies. Incorporate the fertilizer into the soil at land preparation during harrowing and leveling the field. Use the recommendations (Table 3) as a guide for fertilizing your soybean crop.

Soil fertility enhancement

Soybean improves soil fertility and fixes nitrogen in the soil for the succeeding maize (Fig. 4). When grown in rotation with maize, it serves as a catch crop in controlling *Striga hermonthica*, a parasitic weed that attacks maize, by causing suicidal germination of *Striga*.

Table 3. Recommended fertilizer rates for soybean production in Nigeria.

Recommended fertilizer rates (kg/ha)	Materials
20 kg N	2½ × 50 kg bags of NPK (15-15-15)
40 kg P_2O_5	plus 3 × 50 kg bags of SSP (SUPA)
20 kg K_2O	

Pests and diseases

Weeds and their control

Perennial and most annual weeds are a problem in soybean in its early growth stages. A properly timed weed control program can minimize the effects of weeds. Weed control in soybean could be manual or chemical or both.

Manual weed control: Carry out the first weeding at 2 weeks after planting and the second at 5–6 weeks after planting. Avoid weeding immediately after a rainfall as this would lead to transplanting the weeds. Poor hoe weeding or delay in weeding could cause significant reductions in soybean yields.

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. Herbicides are available for pre-emergence or post-emergence weed control in soybean. If herbicide is applied at planting, one weeding may be required at 5–6 weeks after planting. Use herbicides as presented in Table 4.

Insect pests and their control

Several different insects occur in soybean fields but few are normally of any economic importance, and the species that cause damage are usually not abundant enough to warrant control measures. In the vegetative stage, the crop is very tolerant of caterpillars but very susceptible to silverleaf whitefly attack.

Table 4. Recommended herbicide rates for weed control in soybean.

Product	Product rate/ha (L)	Time of application	Remarks
Paraquat plus Pendimethalin (50EC)	3 L of Paraquat plus 3 L of Pendimethalin (250 mL of each/20-L sprayer)	Applied within 2 days of planting	Where grasses, e.g., *Rottboellia* are common
Paraquat plus Dual Gold	3 L of Paraquat plus 2 L of Dual Gold (= 250 mL of Paraquat plus 200 mL of Dual Gold in 15-L sprayer (= 1½ milk tins of Paraquat plus 3/4 milk tins of Dual Gold)	Applied within 2 days of planting	Controls most grasses and broadleaf weeds. Where sowing is done after 1 week of land preparation, application must be within 12 h after planting.
Paraquat plus Butachlor	3 L of Paraquat plus 4 L of Butachlor (= 250 mL of Paraquat plus 350 mL of Butachlor in 15-L sprayer) (= 1½ milk tins of Paraquat plus 2½ milk tins of Butachlor)	Applied within 2 days of planting	Controls most grasses and broadleaf weeds and sedges
Fusilade forte	1–1½ L (150 mL (= 1 milk tin)/15-L sprayer	Postemergence Apply 21–28 days after sowing	For grass weed control
Round-up or other Glyphosate products	4 L (= 350 mL/15-L sprayer)	Preemergence (before land preparation)	Used under no-tillage system, applied at least 2 weeks before sowing also to control perennial weeds

Note: (1) About 12 loads of a 15-L sprayer are required for 1 ha. (2) Where animal power is used for land preparation, allow rain to fall on the prepared land before planting and spray herbicides within 2 days of planting to enhance effectiveness. (3) 150 mL of chemical will fill a standard sized container of liquid Peak milk.

From flowering onwards, soybean becomes attractive to pod-sucking bugs that can seriously reduce seed quality. Insect pests can be controlled with a single spray of Cypermethrin + Dimethoate 10 EC at the rate of 100 mL in 15 L of water.

Diseases and their control

Soybean diseases normally result in major yield losses in Nigeria. Some of the common diseases caused by fungi, bacteria, and viruses are mentioned below.

Fungal and bacterial diseases

Rust: Asian soybean rust, caused by *Phakopsora pachyrhizi*, is one of the most important foliar diseases in Nigeria. The infected leaves have small tan to dark brown or reddish brown lesions (Fig. 5a) on which small raised pustules (or 'bumps') occur on the lower surface of the leaves (Fig. 5b). Pustules produce a large number of spores. Brown or rust-colored powder falls when severely infected leaves are tapped over a white paper or cloth. Severe infection leads to premature defoliation and yield losses up to 80%. The disease is of great economic importance in the derived savanna and southern Guinea savanna zones where rainfall and humidity are high.

Bacterial pustule: The disease is caused by *Xanthomonas axonopodis* pv. *glycines*. Symptoms appear as specks to large, irregular spots with raised light-colored pustules in the elevated centers of the spots on

Figure 5a. Rust-infected soybean leaves with large number of small tan lesions.

Figure 5b. Large number of spores on the lower surface of tan lesions of soybean rust.

Figure 6. Small spots and coalescing lesions of bacterial pustule disease.

Figure 7. *Phytophthora* seedling blight causing wilting of older seedlings.

the lower surface (Fig. 6). The elevated pustules sometimes have cracks in them. Later lesions join together and the dead areas tear away to give a ragged appearance to the leaves. Symptoms of rust and bacterial pustule sometimes appear similar.

Phytophthora seedling blight and root and stem rot: *Phytophthora sojae* causes seedling blight, and root and stem rot. Young seedlings that appear to be established turn off-color to yellow, wilt, and die (Fig. 7). The stems of these plants may show a brown discoloration that begins at the soil line and extends up the stem. The brown, dead leaves remain attached to the plant, and the dead seedlings are obvious symptoms of the disease in the field.

The root rot phase of the disease is rapidly becoming a very destructive disease in Nigeria. The *Phytophthora* fungus can kill plants at all stages of growth. Infected stands may survive but are less productive than healthy stands. Infection generally occurs in fields with poor drainage, but it can occur in normally well-drained fields that are waterlogged for 7–14 days after irrigation or very heavy or prolonged rainfall.

Frogeye leaf spot: The fungus *Cercospora sojina* that survives in infected soybean residue and seeds causes this disease. Symptoms appear

as brown, circular to irregular spots with narrow reddish brown margins on the leaf surfaces (Fig. 8). The central areas of the spots turn ash gray to light brown. Sometimes lesions can develop on stems and pods from where mature seeds are infected. Infected seeds may show discoloration of the seed coat that ranges from small specks to large blotches of light to dark gray or brown.

Figure 8. Initial symptoms of frogeye leaf spot.

To control these diseases:

- Plant resistant varieties. This is the best option to control disease.
- Plant in a good seedbed. Avoid poorly drained or compacted soil.
- Plant seeds treated with fungicides as mentioned earlier under 'seed dressing'.
- Rotate crops with maize to prevent the increase in inoculum levels in a field.
- Use of a foliar fungicide is seldom warranted, except on high-value fields (e.g., seed production fields) or in years when the weather is especially favorable for disease development.

Virus diseases

Soybean is susceptible to several viruses transmitted by aphids, beetles and whiteflies prevailing in Nigeria. Most of the virus infection results in foliar symptoms such as mosaic and mottling, thickening/brittling of older leaves, puckering, leaf distortion, severe reduction in leaf size, and stunting of plants. Mixed infection with more than one virus is common under field conditions. Features of the three most common virus diseases on soybean in Nigeria are presented here.

Figure 9. Mosaic disease-affected soybean plants.

Mosaic disease: Cowpea mild mottle virus (CPMMV; genus *Carlavirus*, family *Flexiviridae*) transmitted by whitefly (*Bemisia tabaci* Gennidius) is the most prevalent virus associated with soybean mosaic disease in Nigeria. In addition, Bean pod mottle virus (genus *Comovirus*, family *Comoviridae*), Alfalfa mosaic virus (genus *Alfamovirus*, family *Bormoviridae*), Cucumber mosaic virus (genus Cucumovirus, family *Bormoviridae*), and Southern bean mosaic virus (genus *Sobemovirus*) were also detected in mosaic disease-affected plants either singly or in mixed infections, particularly with CPMMV. Depending on genotype and age of infection symptoms range from mosaic and mottling, leaf curling, green vein banding, and stunting (Fig. 9). Most severe symptoms are observed in plants infected at early stages of growth (preflowering) and significant reduction in pods.

Yellow mosaic disease: It is caused by whitefly (*B. tabaci*)-transmitted different viruses belonging to the genus *Begomovirus*, family *Geminiviridae*. Soybean yellow mosaic virus was found to be the most prevalent virus associated with this disease. Soybean mottle mosaic virus, which also causes similar symptoms,

Figure 10. Bright yellow mosaic symptoms caused by begomovirus infection in soybean plants.

was found to be less frequent in the fields. Virus-infected plants produce bright yellow mosaic or specks, and develop into large blotches on the leaf lamina (Fig. 10), but this infection does not result in leaf distortion or reduction in lamina size. Mixed infection of these two begomoviruses and CPMMV are common in the fields and such infection results in bright yellow mosaic symptoms and leaf puckering.

Dwarf disease: The causal virus responsible for soybean dwarfing disease is not known. This disease occurs in low frequency in the fields. Leaves and shoots of the infected plants are severely stunted with severe reduction in leaf lamina (Fig. 11). Infected plants do not produce any pods.

Figure 11. Dwarf disease-affected soybean.

Cultivate virus disease-resistant varieties. This is the most convenient, economical, and effective approach for controlling soybean virus diseases. If resistant varieties are not available, the following approaches can contribute to the management of virus diseases in the field.

- Many viruses involved in mosaic disease are seed transmitted in soybean. Use certified seed to avoid seed-borne infection or use seed that are produced away from the infection source.
- Do not plant seeds obtained from mosaic-affected plants.
- Rouge (uprooting and destruction) symptomatic plants. This can reduce the incidence of insect-transmitted viruses.
- Eradicate the weeds and voluntary plants in the vicinity of the soybean farms.
- Treat seeds with systemic insecticides and apply one or two foliar sprays of insecticides to reduce the insect vector activity during preflowering stage (most vulnerable to virus infections) of the plant.

Harvesting soybean

Soybean matures within 3–4 months after planting and requires timely harvesting to check excessive yield losses. At maturity, the pod is straw-colored. It is recommended that soybean be harvested when about 85% of the pods have turned brown for a non-shattering variety but 80% for shattering varieties. Alternatively, the crop can be harvested when the seeds are at the hard-dough stage, when the seed moisture content is between 14 and 16%. Newer varieties are resistant to shattering but losses in yield may occur from other causes if harvesting is delayed. Harvesting can be done with a cutlass, a hoe, or sickles. Cut the mature plants at ground level. Stack them loosely on tarpaulin and allow them to dry in the open for 2 weeks before threshing. Do not harvest by hand pulling because this may remove the nutrient that the soybean has added to the soil.

Figure 12. Manual threshing of soybean.

Postharvest operations

Threshing soybean

Thresh manually or mechanically when the plants are properly dry and as soon as possible. Manual threshing is mainly recommended for small-scale production. It involves piling soybean plants on tarpaulin or putting dry soybean pods in sacks and beating them with a stick. The material is then winnowed to remove the seeds from the debris (Fig. 12).

Use mechanical threshers in large-scale production. Such threshers are equipped with blowers that separate the grains from the chaff (Fig. 13).

Figure 13. A multipurpose soybean threshing machine.

Storage

Soybean should be stored at a moisture content of 10% or less. A soybean seed is sufficiently dry when it cannot be dented with the teeth or fingernails. At harvest, the grains usually contain about 14% moisture. Dry to 13% moisture for storage of 6–12 months and to 10–11% for longer storage. Open-air drying is the most practical way to protect soybean in storage. Place 50-kg or 100-kg bags of clean soybean on a rack in the cold room or in shade. High moisture content in stored soybean encourages the development of various agents of deterioration, such as insects and microorganisms. Good storage management can greatly influence the storability of soybean and subsequent germination when planted in the field. Do not leave soybean exposed to high temperatures, as it will increase deterioration and reduce seed viability.

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