

Better soybean

through good agricultural practices



For farmers in Nigeria



Soybean is a grain legume that is very nutritious and contains on average 40% protein. It can be used directly for food in the household, or processed for soy-milk, cooking oil and a range of other products, including infant weaning food. Also the poultry industry uses soybean for feed production. Soybean grain often has a good market demand. The crop residues are also rich in protein and are good feed for livestock or form a good basis for compost manure.

Soybean forms root nodules which contain bacteria called rhizobia. The bacteria can fix nitrogen from the air into a form that soybean can use for growth. This is called biological nitrogen fixation. Some of the nitrogen is also left behind through falling leaves and roots to improve soil fertility. This makes soybean a good crop to grow as intercrop or in rotation with other crops, because these other crops then also benefit from the nitrogen. In addition, soybean has the potential to control the parasitic weed *Striga hermonthica*.

To form nodules and fix nitrogen, soybean needs specific rhizobia. In most soils, these rhizobia are not abundant. Thus inoculating soybean seed with the correct rhizobium increases biological nitrogen fixation and gives a good yield for very little cost. With good practices and the right varieties, grain yields can be as high as 2500 – 3000 kg/ha when grown as a sole crop.

Step 1: Land selection and preparation

- Soybean can be grown on a wide range of soils with a pH between 4.5 and 8.5.
- Avoid waterlogged, or very sandy, gravelly soils.
- Think about the rotation scheme for the field you want to plant. Do not plant soybean in the same field for two succeeding seasons, as this increases the chance for disease.
- Well-prepared land ensures good germination and reduces weed infestation. Clear all vegetation and prepare the field manually with a hoe, or use animal power or a tractor.
- You can plant soybean on ridges or on a flat seedbed.

Step 2: Variety and seed selection



Select a good soybean variety which suits your agro-ecological zone. Suitable areas for soybean in Nigeria are the Northern Guinea and Southern Guinea savannas and Sudan savannah. Pay attention to the maturity period of the variety. Some varieties have a relatively short maturity period and are suitable for areas with low rainfall, or when planted late in the season. Always use an early or extra-early variety when growing soybean in the drier Sudan savanna zone. Late maturing varieties are less suitable for drier environments, but often produce higher grain and biomass yields, fix more nitrogen and contribute more to soil fertility than early maturing varieties.

Variety	Maturity period (days)	Characteristics	Pest/diseases resistance
TGX1835 - 10E	early	Good grain colour, low shattering, 15-20% oil in grain	Resistant to pests; resistant to rust and pustules
TGX 1448 – 2E	medium	Excellent grain colour, low shattering, 15-20% oil in grain	Resistant to common pests and diseases
TGX 1485 – 1D	early	Good grain colour, low shattering, 15-20% oil in grain	Resistant to common pests; resistant to pustules but susceptible to rust
TGX 1904 – 6F			Resistant to common pests; resistant to pustules but susceptible to rust
TGX 1951-3F	early	Low shattering, 15-20% oil in grain	Tolerant to rust, cercospora leaf spot and bacterial pustules. Also tolerant to poor soil.

* All these varieties are planted at a seed rate of 40-50 kg/ha and have 2000-3000 kg/ha attainable grain yield



Use only high quality seed for planting.

- Make sure seed is 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 a germination test at least 10 days before planting. Plant 50 seeds. If at least 40 emerge, the seed is good for planting. If 30-40 emerge, plant more seeds than recommended. Get new seeds if less than 30 seeds emerge.

Step 3: Inoculation



To be able to form nodules and fix nitrogen, soybean seeds need to be inoculated with rhizobia. Each legume crop needs a different type of rhizobium bacteria, so always check you have the right inoculant for soybean.

How to inoculate soybean with Legume Fix

1. Measure 15 kg of soybean. Place in any container that will accommodate the seed.
2. When seed is a bit dusty, a small amount of water (30 ml, 6 teaspoons or soda bottle-tops) can be mixed with the seeds.
3. Add 75 gram (7 tablespoons) of inoculants to the seeds.
4. Mix the seeds and the inoculant thoroughly until all the seeds are uniformly covered.
5. Protect the inoculated seed from direct sunlight by covering the container with paper, cloth or gunny bag and keep under shade until planted.
6. Plant the seeds on the same day you inoculate them.
7. Place the inoculated seed in a well-prepared moist furrow and cover immediately with soil.

You can adjust the volumes above to any quantity of soybean seed. Per kg seed, use 7 g (1.5 heaped teaspoons or soda bottle-tops) inoculant.

How to inoculate depends on the type of inoculant you use. The above instructions are for Legume Fix inoculants. Therefore always check the instructions on the package or ask an agro-dealer or extension worker.



Six facts about inoculants:

1. The roots of legumes and rhizobium bacteria work together to biologically fix nitrogen. Inoculants contain the bacteria that help the soybean to fix nitrogen.
2. Inoculants are much cheaper than nitrogen fertilizer.
3. Each legume crop needs a different type of rhizobium bacteria, so always check you have the right inoculant for the crop you want to sow.
4. Inoculants lose their effectiveness when stored in an open package. Therefore do not open the package until you are ready to use it.
5. Inoculants also lose their effectiveness when exposed to heat or direct sunlight. Therefore always store the package in a cool place in the house.
6. Directions for using inoculants can be found on the package.

Step 4: Applying fertilizer



Important points

- Soybean can fix its own nitrogen, and therefore does not need to be fertilized with nitrogen fertilizers such as ammonium nitrate or urea.
- Soybean cannot fix other nutrients, and needs other nutrients such as Phosphorus (P) or Potassium (K) at planting.
- Good fertilizer types for soybean that supply phosphorus are Single Super Phosphate (SSP) and Triple Super Phosphate (TSP). Both fertilizers also contain calcium (Ca), and SSP also contains sulphur (S). TSP contains more phosphorus than SSP.
- Diammonium Phosphate (DAP) contains both phosphorus and nitrogen. If SSP or TSP is not available you can use DAP. The nitrogen content of DAP is small compared to its phosphorus content.
- Muriate of Potash (MOP) supplies potassium. Use MOP in combination with one of the P-fertilizers mentioned above.

Application

- Make furrows along the rows of soybean. The furrows should be 8 cm away from the soybean plants and 5 cm deep. Place the fertilizer in the furrows and cover with soil. Do this at planting or right after planting.
- Soybean needs about 30 kg P/ha (30 kg P_2O_5 /ha) and about 25 kg K/ha (30 kg K_2O /ha). Use the fertilizer rates given in the table below for mono-cropped soybean. You can use a teaspoon or soda bottle-cap to measure the amount of fertilizer.
- When manure has been applied recently, you can reduce the fertilizer rates.



Fertilizer type	Rate (kg/ha)	Row spacing: 50 cm		Row spacing: 75 cm	
		In a furrow, apply 1		In a furrow, apply 1	
		<i>Teaspoon</i>	<i>Soda bottle-cap</i>	<i>Teaspoon</i>	<i>Soda bottle-cap</i>
SSP	150	Every 80 cm	Every 55 cm	Every 60 cm	Every 40 cm
TSP	75	Every 330 cm	Every 220 cm	Every 220 cm	Every 150 cm
DAP	75	Every 240 cm	Every 160 cm	Every 160 cm	Every 110 cm
MOP	50	Every 300 cm	Every 200 cm	Every 200 cm	Every 130 cm

Step 5: Planting



Planting

- Plant in the morning or evening to avoid direct sunlight on the inoculated seed. The sunlight will make the inoculant ineffective.
- Planting in rows has many advantages; you use the correct plant density, weeding is easier and harvesting takes less time.
- Plant at 2-5 cm depth. Planting deeper than 5 cm may results in loss of vigour or failure to emerge.
- Fill gaps one to two weeks after sowing when plants have emerged.

Spacing of mono-cropped soybean

<i>Soybean type</i>		<i>Spacing</i>
Late maturing	1 seed per stand	75 x 5 cm
	2 seeds per stand	75 x 10 cm
Early maturing	1 seed per stand	50 x 5 cm
	2 seeds per stand	50 x 10 cm

Intercropped soybean

Alternatively to growing soybean as a sole crop, you can intercrop soybean with a cereal crop. Soybean does not grow well when shaded. Therefore it is best grown in strip intercrops with 2-4 rows of soybean and 2 rows of a cereal crop. Soybean can also be planted in between rows of newly-established crops of cassava. Use the recommended planting distances for both crops.

Step 6: Field management



Weeds

Control weeds to minimize competition for nutrients, water, sunlight and space. Weed control can be manual or chemical, or both.

Manual weed control:

Weed about 2 weeks after planting and again 5-6 weeks after planting. If the plants grow very well and the canopy closes early, the second weeding is not needed.

Chemical weed control:

Herbicides, if used properly, are safe and effective in controlling weeds. There are different types of herbicides. Which type to use depends on the predominant weed species and the availability of the herbicide.

Herbicides are available for pre-emergence or post-emergence weed control. If pre-emergence herbicide is applied at planting, one weeding may be required at 5-6 weeks after planting. Use herbicides as presented in the table below or seek advice from an extension agent.

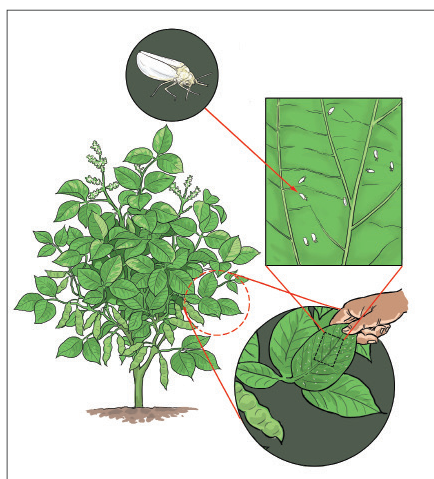
The following herbicides are applied at pre-emergence:

Product name	Active ingredient	Use rate	For which type of weeds
Paraquat plus	Paraquat dichloride	3 l/ha	Rottboellia
Paraquat + dual Gold			
Buta Force	Butachlor	4 l/ha	Most grasses and broadleaf weeds
Round Up	Glyphosate		

Pests and diseases

Insect pests

Common pests affecting soybean in Nigeria are caterpillars and whitefly. If pests are damaging leaves, you do not have to spray, as leaf damage is unlikely to reduce the yield. From flowering onwards, soybean becomes attractive to pod-sucking bugs that can seriously reduce seed quality.



White flies

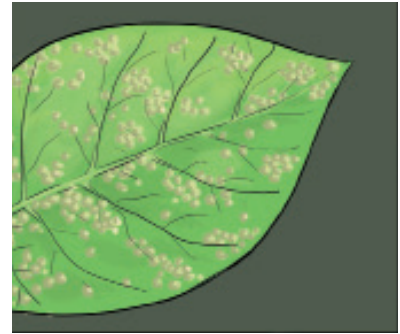
If pests are damaging pods, control the pest with insecticides. Always follow the manufacturer's recommendations or seek advice from an extension agent.

Product name	Name of active ingredient	Use rate	Amount for one sprayer load	For which pest
MagicForce	Lambda-cyhalothrin + Dimethoate	0.4-0.8 l/ha	35 – 70ml in a 15 l sprayer	Control of leaf, seed and soil dwelling insects and migratory insects.
CyperDiForce	Cypermethrin + Dimethoate	1 l/ha	75ml in a 15 l sprayer or 100ml in a 20 l sprayer	
Wormforce	Carbufuran	25 - 100 kg/ha	3g/plant or 7-10g/m ² of soil during seed-bed preparation	Controls foliar and soil-borne insects and nematodes

Diseases

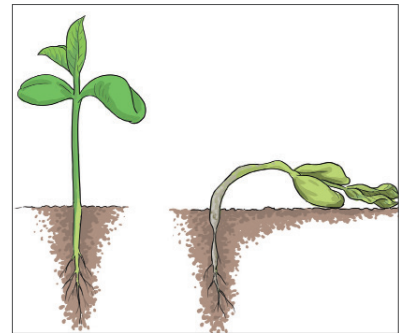
Fungal diseases

Soybean rust: Infected leaves have small tan to dark brown or reddish brown lesions. From the lesions, small raised pustules or bumps can occur on the lower surface of the leaves. Severe infection leads to premature defoliation and can cause high yield losses.



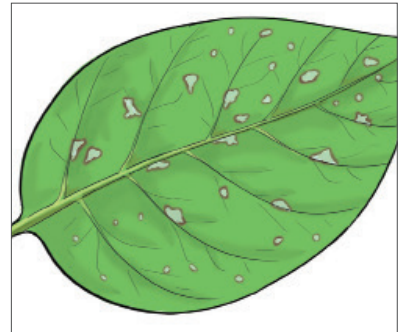
Soybean rust

Seedling blight (damping off): Is a seed borne fungal disease. The disease cause rotting of seeds before emergence from the soil or death of seedlings after emergence. When seedlings emerge from the soil, they often have brown, sunken cankers on the leaves, which can become covered with pink spores in moist weather. The disease is favoured by cool wet weather.



Seedling blight (damping off)

Frog eye leaf spot: Symptoms consist of brown, circular to irregular spots with narrow reddish brown margins on the leaf surfaces. When mature seeds are infected, lesions can develop on stems and pods. Infected seeds may show dark grey or brown discoloration in small specks to large blotches. The fungus survives in infected crop residues and in infected seeds.



Frog eye leaf spot

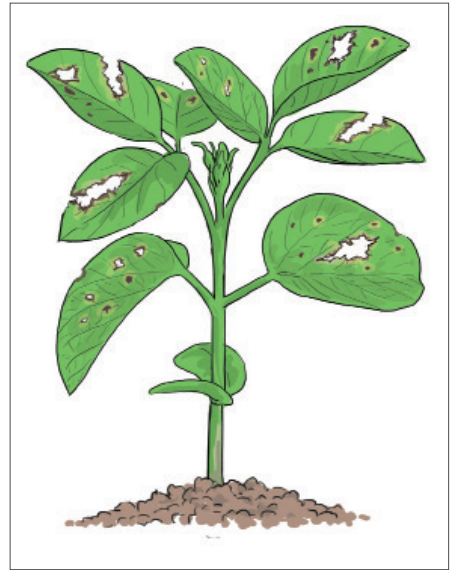
Root and stem rot: Roots and stems turn a chocolate brown colour and the leaves turn yellow and wilt. Sometimes, a lesion occurs on one side of the plant. When the plant dies, the wilted yellow leaved cling to the plant. The fungus can infect seeds, seedlings and plants during the whole growth period, but especially when soil conditions are very moist and on soils that are poorly drained.



Root and stem rot

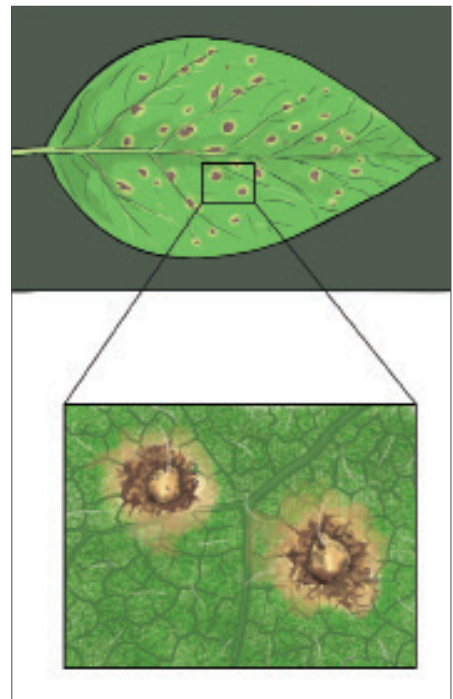
Bacterial diseases

Bacterial blight: When plants are infected early in the season they may be stunted and die. Symptoms in later growth stages consist of angular lesions, which begin as small water-soaked yellow to light brown spots on the leaves. The centres of the spots will turn a dark reddish-brown to black and dry out. Water-soaked tissue then surrounds the lesions and is bordered by a yellowish-green halo. Eventually the lesions will fall out of the leaf. The disease spreads during windy rainstorms and during cultivation while the foliage is wet. The bacteria are carried over in crop debris and in infected seeds. Seeds usually do not show symptoms.



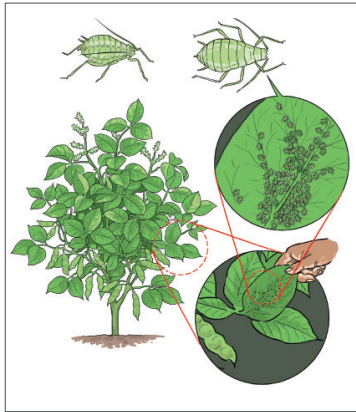
Bacterial blight

Bacterial Pustule: Symptoms first look like those of bacterial blight. Small yellow-green spots with reddish-brown centres occur on the leaves. Usually, small raised pustules appear from the centre of the lesions. The presence of a pustule and the absence of water soaked parts distinguish bacterial pustule from bacterial blight. In a later stage, the small lesions may connect and form large, irregular, cracked, brown areas with a yellow margin. The disease is seed borne and the bacteria causing the disease over-season in diseased crop debris.

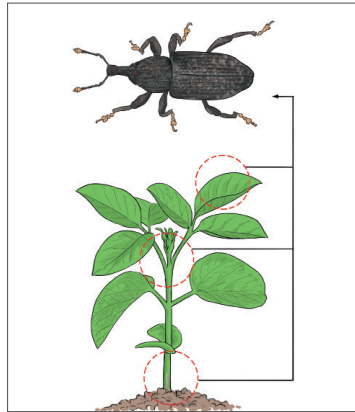


Viral diseases

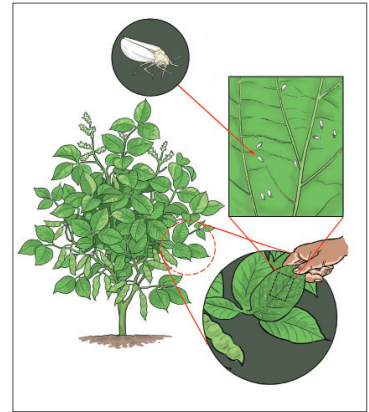
Viral diseases can be transmitted by aphids, beetles and whiteflies. Soybean seeds originating from infected plants can also carry viruses. Most of the viral diseases result in foliar symptoms such as mosaic and mottling, thickening/brittling of older leaves, puckering, leaf distortion, severe reduction in leaf size, and stunting of plants.



aphids



snout beetle



white flies

To control fungal and bacterial diseases:

- Plant resistant varieties.
- Plant in a good seedbed and avoid poorly drained or compacted soils.
- Rotate soybean with non-legumes to prevent the build-up of diseases.
- You can treat seeds with fungicides (for example *Captan*, *Apron Plus* or *Thiram*, use 1 sachet/8 kg seed) for protection against soil-borne fungal diseases.

To control viral diseases:

- Plant resistant varieties.
- Many viruses involved in mosaic disease are seed transmitted. Therefore, do not plant seeds from mosaic-affected plants. Instead, use certified seed or use seeds that produced away from the infection source.
- Uproot and destroy affected plants. This can reduce the incidence of insect-transmitted viruses.
- Control weeds in and around the soybean farms.
- Soybean is most vulnerable to virus infections in the pre-flowering stage. During this period, you can spray one or two times with insecticides to reduce the number of insects that can transmit viruses.



Safe use of chemicals

- Use only herbicides, pesticides and fungicides that are recommended to soybean to avoid damage to the plant.
- Chemicals can be toxic, so always follow instructions on the product package or from the agro-dealer for safe use. Also follow the instructions about the time needed between spraying and safe consumption of fresh pods.
- Do not store chemicals in the same place as food.
- Do not eat from the same spoon used to measure chemicals.

Step 7: Harvesting



Soybean should be harvested when 9 out of 10 pods are mature (brown or dry). Leaving the crop in the field too long makes the pods very dry, so they might shatter during harvest. To avoid shattering, it is best to harvest early in the morning.

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, hoe or sickles. Make sure grain of different varieties is not mixed. Mixed grains lower the market value.

1. Dry the soybean plants in the sun and protect from rain and animals. Preferably, dry on a mat, plastic sheet or tarpaulin, or on a raised platform.
2. Thresh gently on a clean surface when the plants are dry.
3. 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 finger nails - grain should break or crack, not bend or stick between your teeth or fingernails.
4. Clean the grains. Winnow to remove chaff, dust and other rubbish. Also remove shrivelled, diseased, broken grains and grains of other varieties.
5. Place grain in clean bags or other containers; if re-using bags in which grain was previously stored, the bags must first be washed and then disinfected by boiling them in water for 5 minutes. If the bag is polyethylene, make sure it doesn't touch the outside of the pot or it will melt. Completely dry the container/bag.
6. Grain can be treated before storage to control storage pests. Coating grain with ash or edible oil reduces storage pests. You can also use chemicals. Ask an agro-dealer or extension agent for advice



7. You can also use PICS (Purdue Improved Cowpea Storage) triple bags to store grain under air-tight conditions and keep away insects from the grain. Place grain in the innermost bag and tie this bag tightly, then tie the middle bag, and finally tie the outermost bag. When all the bags are tied, any insects in the grain die from lack of oxygen. It is not necessary to treat seed against storage pests when using PICs bags.
8. Clean the storage room; remove all old grains and insects. Do not store grain which is to be eaten in the same place as pesticides or other dangerous chemicals. Stack the grain bags on a raised platform or wooden pallet away from the wall. Avoid direct contact of storage bags with the ground. Inspect and remove infested or rotting grains on a regular basis.

Using soybean

- The first step in making delicious soybean dishes is to put the dried grain in boiling water and quickly cook for 20-30 minutes. This reduces anti-nutritional factors - these factors can interfere with absorption of nutrients. Then remove the skin and dry. Soybean develop a bad flavour if the cooking step is left out.
- Soybean flour can be made by grinding the pre-boiled and dried grains. The soybean flour can be mixed with cassava or maize meal to make a very nutritious soybean bread or soybean cakes.
- Grains can be roasted and eaten as snacks, much like groundnut.
- The grains can also be used in a variety of dishes as relish.
- Soaked and pounded soybean can be used to make soy milk and tofu.
- Ask an extension agent for more soybean recipes!
- Crop residues can be fed to livestock or composted. Because the residues are rich in nitrogen, bringing them back in the form of compost or manure from the livestock enriches your field in nitrogen.

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