

Better soybean

through good agricultural practices



For farmers in Ethiopia



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 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 3500 – 4000 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.
- Soybean can be grown on ridges or on a flat seedbed.

Step 2: Variety and seed selection



Select a good soybean variety which suits your agro-ecological zone. 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. 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.

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.

	Variety	Grain Yield (kg/ha)	Maturity period (days)	Resistant to	Ecology/Region (where grown)	
1	Gizo	1700-2100	94-104	Bacterial purple, blight and viral diseases	Long rainfall areas of western and south western part of the country	
2	Wegayen	1800-2100	101-109			
3	Gishama	1500-1800	90-100			
4	Awassa-95	1700-2600	90-120			Short rainfall areas, Western and South Western part of the country
5	Belesa-95	1700-2900	134-169	Bacterial purple, blight	Long rainfall areas of western and south western part of the country	
6	Boshe	1600-3000	117-124	Bacterial purple, blight and viral diseases	Intermediate & long rainfall areas	
7	Cheri	1500-2200	120-135	Bacterial purple, blight		
8	Dhidhessa	2000-3300	137-145	Bacterial purple, blight and viral diseases		
9	Jalale	1600-2100	121-133	Bacterial purple, blight		
10	AFGAT	1500-2900	121-150	Anthracnose		
11	Clark 63K	1500-2000	90-120			Short rainfall areas of western and south western part of the country
12	Cocker 240	1500-2500	121-150	Bacterial purple, blight and viral diseases		Intermediate & long rainfall areas
13	Crawford	1500-2000	90-120			Short rainfall areas of western and south western part of the country
14	Davis	1500-2500	121-150			Intermediate & long rainfall areas
15	TGX-13-3-2644	2000-2500	134-169			Long rainfall areas of western and south western part of the country
16	Williams	1500-2000	90-120		Short rainfall areas of western and south western part of the country	

* All varieties except 13 (Crawford) and 16 (Williams) have indeterminate growth habits. Crawford and Williams have determinate growth habits.

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. Directions for using inoculants can be found on the package.

How to inoculate soybean seeds

1. Measure 15 kg of legume seed, this will be approximately 15 litres. Place in any container that will accommodate the seeds.
2. Measure one soda bottle (300 ml) of clean lukewarm water.
3. Pour the water into a larger bottle (500 ml plastic bottle) so that it is easier to mix the sugar.
4. Add 2 tablespoons of sugar to the water.
5. Mix thoroughly to get an even solution of sugar. This solution is called the sticker.
6. Add the sticker to the seed.
7. Mix the seed with sticker solution until all the seeds are evenly coated with the sticker.
8. Add the rhizobium inoculant onto the seeds and sticker. The inoculant is the 125 g black powder contained in the pack.
9. Mix the seeds and the inoculant thoroughly but gently until all seeds are uniformly covered with the inoculant.
10. Protect the inoculated seed from direct sunlight by covering the container with paper, cloth or gunny bag and keep under a shade until planted.

For smaller amounts of seed, use 4 teaspoons or soda bottle-tops (20 ml) of the sticker solution, and 2 heaped teaspoons or soda bottle-tops (10 g) of inoculant for every 1 kg of seed.



Facts about inoculants:

- The roots of legumes and rhizobium bacteria work together to biologically fix nitrogen. Inoculants contain the bacteria that help the soybean to make nitrogen.
- Inoculants are much cheaper than nitrogen fertilizer.
- 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.
- Inoculants lose their effectiveness when stored in an open package. Therefore do not open the package until you are ready to use it.
- Inoculants also lose their effectiveness when exposed to heat or direct sunlight. Therefore always store the package in a cool place in the house.
- Directions for using inoculants can be found on the package.

How to inoculate depends on the type of inoculant you use. Always check the instructions on the package or ask an agro-dealer or extension worker.

Step 4: Applying fertilizer



Important points

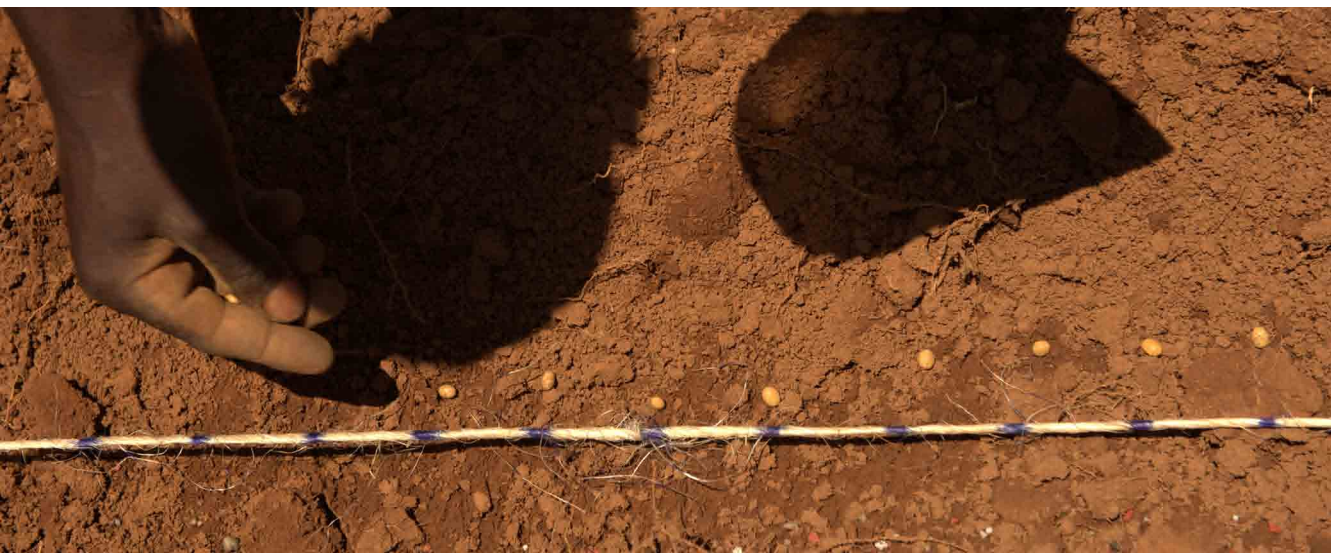
- Soybean can fix its own nitrogen, and therefore you do not need to apply nitrogen fertilizer like urea.
- Soybean cannot fix other nutrients, and therefore you do need to apply other nutrients such as phosphorus at planting.
- Good fertilizer types for soybean that supply phosphorus are DAP or NPS.

Application

- Place fertilizer directly in the furrows made for planting, and cover with 2-3 cm of soil before placing the seed. If you don't cover the fertilizer with soil before placing the seed, the fertilizer will burn the seed.
- You can also apply fertilizer in a furrow of 5 cm deep, next to the rows of soybean.
- Use the fertilizer rates given in the table below. You can use a teaspoon or soda bottle-cap to measure the amount of fertilizer.
- When manure has been applied recently, rates can be reduced.

Fertilizer type	Rate (kg/ha)	Row spacing: 60 cm		Row spacing: 40 cm	
		Along a furrow, spread 1		Along a furrow, spread 1	
		Teaspoon	Soda bottle-cap	Teaspoon	Soda bottle-cap
DAP	100	Every 2½ feet	Every 1¾ feet	Every 4 feet	Every 2½ feet
NPS	100	Every 2½ feet	Every 1¾ feet	Every 4 feet	Every 2½ feet

Step 5: Planting



Planting

- Plant when the rains are well established to avoid dry spells after planting.
- Plant in the morning or evening to avoid direct sunlight on the inoculated seed. 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 result 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

Spacing between rows and within rows depends on the variety. Generally, early maturing varieties need closer spacing than late maturing varieties.

- Plant early maturing varieties in rows which are 40 cm apart. Within rows, plant seeds at 5 cm apart from each other (1 seed per stand).
- Plant late maturing varieties in rows which are 60 cm apart. Within rows, plant seeds at 5 cm apart from each other (1 seed per stand).

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 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.

Brand or common name	Name of active ingredient	Use rate (L/ha)	Time of application	For which type of weeds
Fusilade	Fluzifop-p-butyl	0.25 kg a.i. ha-1	Pre-emergence	grass weeds
Lasso	Alachlor 480 EC	4 lt/ha	Pre-emergence	broad leaf weeds
Dual Gold	S-metolachlor 960 EC	1 lt/ha	Pre-emergence	broad leaf weeds

Pests and diseases

Insect pests

Common pests affecting soybean in Ethiopia are African bollworm, cut worm, green stink bug, and the aphid. 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 than can seriously reduce seed quality.



If pests are damaging pods, control the pest with spraying with insecticides. Be aware of aphids, as they can transmit viruses to soybean. Always follow the manufacturer's recommendations or seek advice from an extension agent.

<i>Product name</i>	<i>Name of active ingredient</i>	<i>Use rate (L/ha)</i>	<i>For which pest</i>
Pirimicarb	Primor 50%WP	0.5kg a.i./ ha	aphids
Cypermethrin	Cymbush 10% EC	150g a.i./ ha	African ball worm
Agro-Thoate	Dimethoate 40% EC	1 lt/ha	Beanfly, bean aphid, thrips, African ball worm

Diseases

Soybean diseases can be caused by fungi, bacteria or viruses and can result in major yield losses.

Fungal diseases

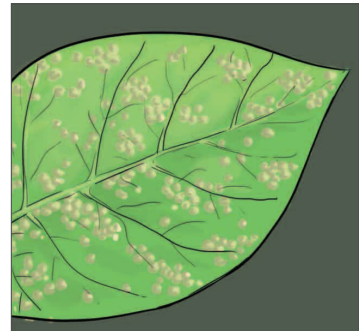
Soybean rust: Infected leaves have small tan to dark brown or reddish brown lesions. From the lesions, small raised pustules or bumps can occur on the lower surface of the leaves. Severe infection leads to premature defoliation and can cause high yield losses.

Purple seed stain: Infected seeds show pink or purple spots or become entirely pink or purple. The seed coat often cracks. When infected seeds are planted, the fungus grows into the seedling leaves and stems and produces spores. The spores are spread by wind and rain splash and in turn infect leaves, stems and pods of other plants.

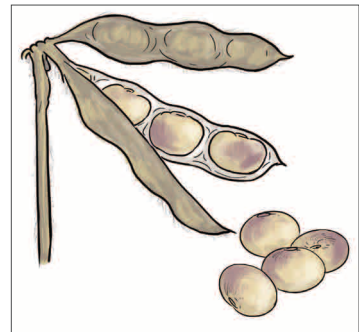
Bacterial diseases

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 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.



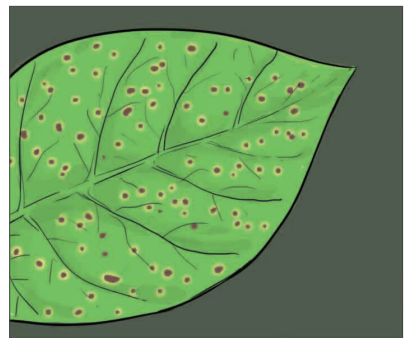
Soybean rust



Purple seed stain



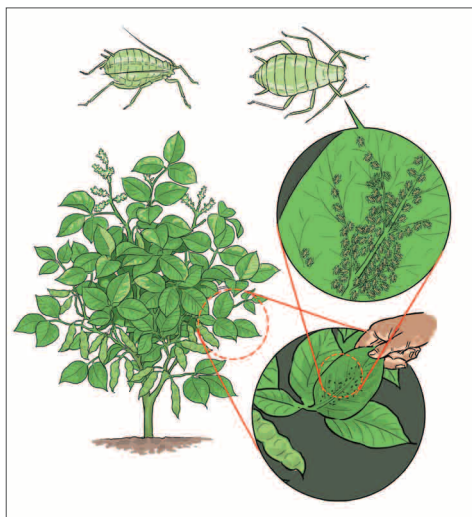
Bacterial blight



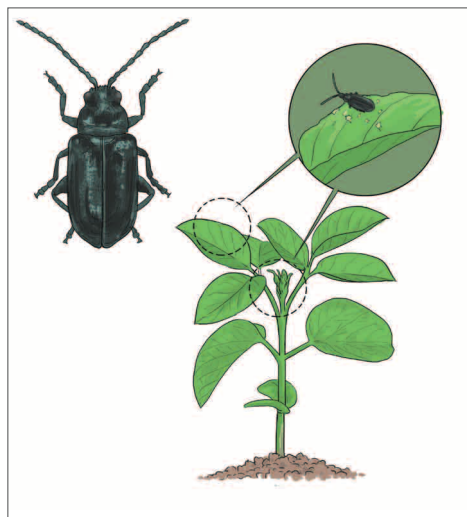
Bacterial pustule

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



flea beetle

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 built-up of diseases.
- You can treat seeds with fungicides (for example *Actellic*, *Apron Star* 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 were 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 you 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 grain. 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 you reuse 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 container/bag.
6. Grain can be treated before storage to control storage pests. For example coat grain with vegetable oil, or insecticides such as *Primiphosmethyl*.
7. 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 boil the dried grain for 20-30 minutes. This reduces anti-nutritional factors - these factors can interfere with absorption of nutrients. Then remove the skin from the boiled grains and dry. Soybean develops 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 porridge, or for baking 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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