

Better soybean

through good agricultural practices



For farmers in Tanzania



Soybean is a nutritious grain legume which 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 soil organic matter.

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 strain 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 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. Also pay attention to the maturity period. 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.

<i>Variety</i>	<i>Grain characteristics</i>	<i>Grain yield (kg/ha)</i>	<i>Maturity period (in months)</i>	<i>Growth habits</i>	<i>Diseases resistance</i>
Bossier	Colour: cream Size: medium Oil: 30-40% Shattering: low	1000-2000	3	Determinate	Moderately resistant to leaf rust, tolerant to other diseases
Uyole soya 1	Colour: cream Size: large Oil 35-40% Shattering: very low	1000-2500	4	Determinate	Moderately resistant to other diseases, susceptible to soybean rust
Uyole soya 2	Colour: cream Size: large Oil: 35-40% Shattering: very low	1000-2500	4	Determinate	Moderately resistant to other diseases, susceptible to soybean rust
Uyole soya 3	Colour: cream Size: large Oil: 35-40% Shattering: very low	1000-2500	4	Indeterminate	Moderately resistant to other diseases, susceptible to soybean rust

* *The seed rate for all the above varieties is 60-80kg/ha*



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

Soybean fixes nitrogen in its root nodules. Inoculate soybean seeds with rhizobia to ensure nodule formation. Each legume crop needs a different type of rhizobium bacteria, so always check you have the right inoculant for soybean. You can find directions for using inoculants on the inoculant package, or below.

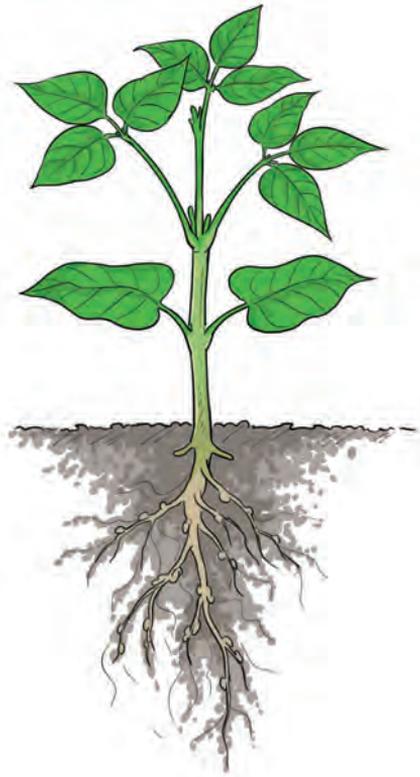


How to inoculate soybean using solid-dry inoculants (Legumefix)

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. You can adjust the volumes above to any quantity of soybean seed. Per kg seed, use 4 gram (1 heaped teaspoons or soda bottle-tops) inoculant.

How to inoculate soybean using solid-wet inoculants (Biofix)

1. Measure 15 kg of legume seed. Place in any container that will accommodate the seeds.
2. Measure one soda bottle (300 ml) of clean lukewarm water.
3. Add the 30 g of gum arabic contained in the Biofix pack (the whitish material) or 2 tablespoons of sugar to the water.
4. Mix thoroughly to get an even solution of gum arabic (or sugar). This solution is called the sticker. Add the sticker to the seed and mix until all the seeds are evenly coated with the sticker.
5. Add the rhizobium inoculant onto the seeds and sticker. The inoculant is the 100 g (10 tablespoons) black powder contained in the Biofix pack.
6. Mix the seeds and the inoculant thoroughly but gently until all seeds are uniformly covered with the inoculant.
7. Protect the inoculated seed from direct sunlight by covering the container with paper, cloth or gunny bag and keep under shade until planted.
8. Plant the seeds on the same day you inoculate them.
9. You can adjust the volumes above to any quantity of soybean seed. Per kg 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



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. Therefore 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 or CAN. 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 SSP, TSP, DAP or Minjingu Phosphate 9. However, SSP and TSP are not readily available in Tanzania. Choose Minjingu Phosphate when the pH of the soil is below 5.6.

Application

- Apply fertilizer directly in the furrows made for planting. The furrow should be 5-7 cm deep. Place the fertilizer in the furrow and cover with 2 cm of soil. If you don't cover the fertilizer with soil, the fertilizer will burn the seed.
- Use the fertilizer rates given in the table below. Spread the recommended amount of fertilizer equally over the furrows. If you want to do this very precisely, you can use a teaspoon or soda bottle-cap.

Fertilizer type	Rate (kg/ha)	In the furrow, spread 1	
		Teaspoon	Soda bottle-cap
TSP, DAP	100	Every 1 meter	Every 60 cm
SSP	225	Every 40 cm	Every 30 cm
Minjingu	250	Every 40 cm	Every 25 cm

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.
- Plant in rows. This 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

- When you plant soybean on flat land, plant the soybean in rows which are 45 cm apart. Within rows, plant seeds at 5 cm apart from each other (1 seed per stand).
- When you plant soybean on ridges, space the ridges 60 cm apart. Plant soybean on both sides of the ridges. Within rows, plant seeds at 5 cm apart from each other (1 seed per stand).

Intercropped soybean

As an alternative 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. You can also plant soybean 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.

Brand or common name	Use rate	Amount for one sprayer load (15 l knapsack)	Time of application	For which type of weeds
Bean clean	1.2 l/ha	80-150 ml	Post emergence	Di & monocots
Sateca	1.2-1.5 l/ha	80-120 ml		

Pests and diseases

Insect pests

Common insects affecting soybean in Tanzania are aphids, cutworms and bugs. If pests are damaging leaves, you do not have to spray, because leaf damage is unlikely to reduce the yield. From flowering onwards, soybean becomes attractive to pod-sucking bugs than can seriously reduce seed quality. Also be aware of aphids, because they can transmit viruses to soybean.

If insect pests are damaging pods, you can control the pest with insecticides. 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>Amount for one sprayer load</i>	<i>For which pest</i>
Dursban	Chlorpyrifos	1	25 ml in 15 l water	Aphids, cutworms
Karate	Lambdacyhalothrin	1		
Selecron		1		

**** If unsure about how to manage pests, seek advice from an extension worker or agrodealer.***

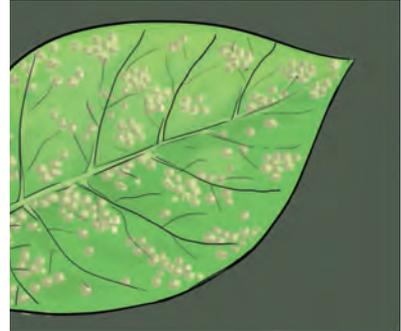


Diseases

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.



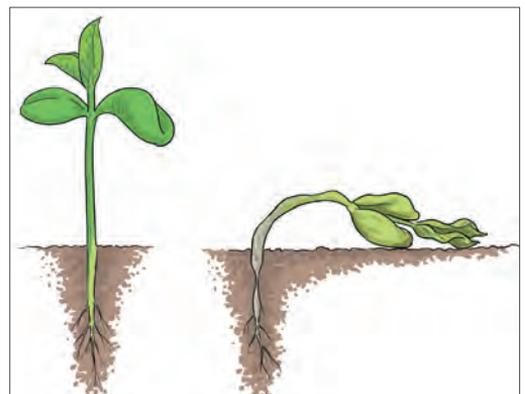
Soybean rust

Downy mildew: Symptoms include yellowish-green areas with indefinite borders on the upper surface of the leaves. At a later stage, the infected areas enlarge and become brown and papery. Severely infected leaves die and fall off. The disease also attacks the pods and infects the seeds. Downy mildew is favoured by cool weather.



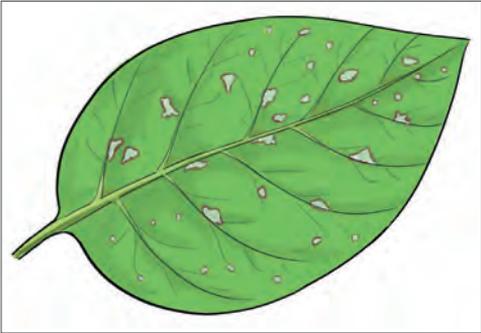
Downy mildew

Damping off and anthracnose: are seed borne diseases caused by several fungi. The diseases 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. Damping off and anthracnose are favoured by cool weather.



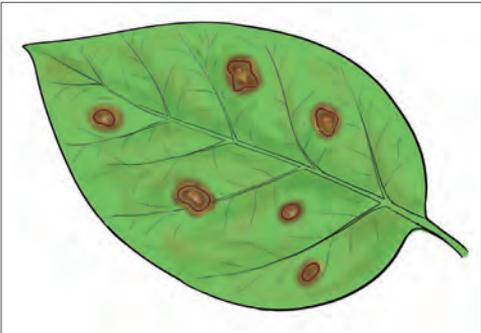
Damping off and anthracnose

Frogeye 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.



Frogeye leaf spot

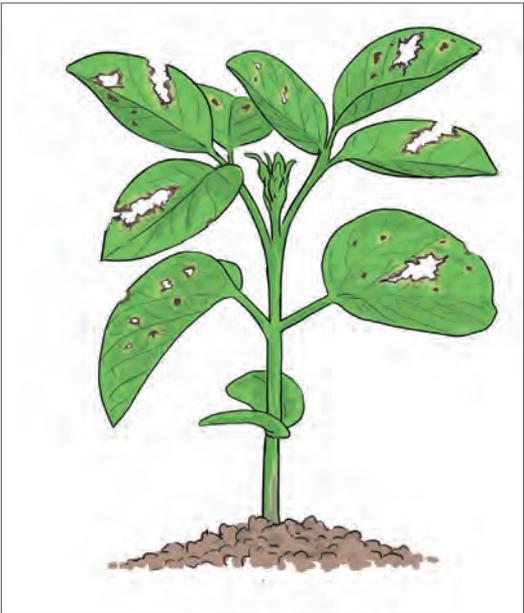
Red leaf blotch: In the first stage of the disease lesions appear on unifoliolate leaves associated with primary leaf vein. At this point the disease is easily confused with other diseases or cultural conditions affecting soybeans. Later, dark red spots on the upper leaf surfaces and similar spots with reddish brown and dark borders on the lower leaf surfaces develop on trifoliolate leaves.



Red leaf blotch

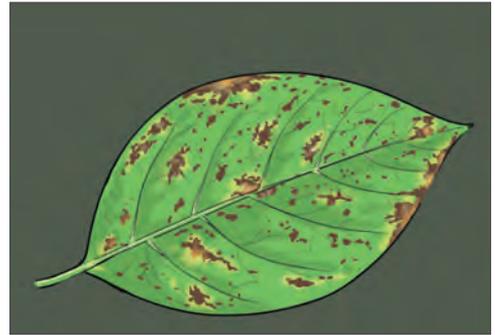
Bacterial diseases

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

Wildfire: Symptoms consist of light-brown necrotic spots of variable size, surrounded by broad yellow halos on the leaves. In damp weather the spots enlarge forming large dead areas on the leaf. Wildfire disease is commonly associated with bacterial blight. The bacteria causing wildfire are seed-borne and also are carried over in crop debris.



Wildfire

Viral diseases

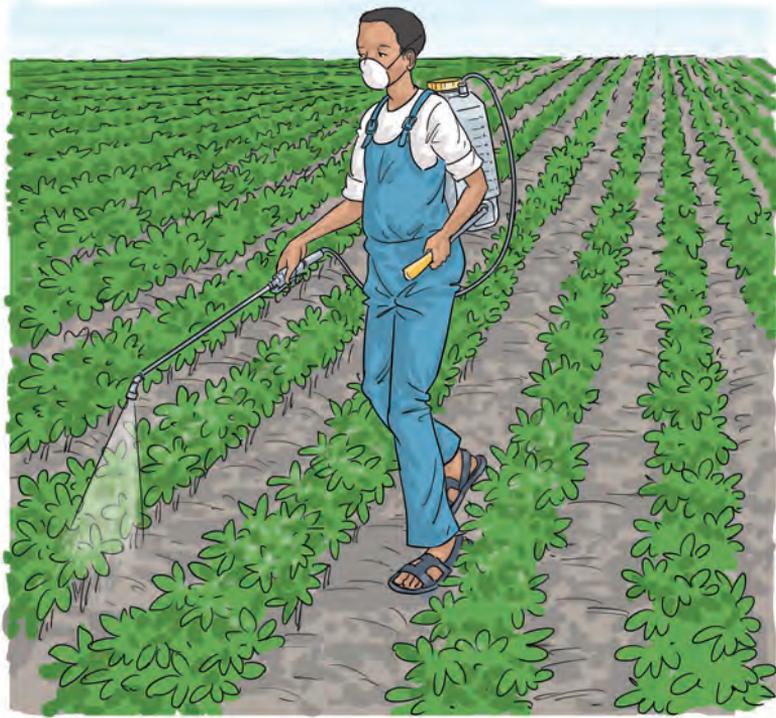
Viral diseases can be transmitted by aphids, beetles and whiteflies. Soybean seeds originating from infected plants can also carry viruses. Most of the viral diseases result in foliar symptoms such as mosaic and mottling, thickening/brittling of older leaves, puckering, leaf distortion, severe reduction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

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 from healthy plants only.
- 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 agrodealer 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.

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. For example, coat grain with *Actellic Super*. Coating grain with edible oil or ash also reduces insect pests.
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.
9. Finally, do not throw away or burn the residues. Soybean crop residues are rich in nitrogen and therefore excellent as livestock feed, or a good basis for compost. You can also incorporate the residues in the field directly.

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 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.

This leaflet was produced by N2Africa in October 2014 for farmers in Tanzania. It is available on the website of N2Africa and the Africa Soil Health Consortium (ASHC) - (www.cabi.org/ashc) as Creative Commons material which can be reproduced and re-used without permission - provided N2Africa and ASHC are credited. The content was developed by N2Africa, ARI Uyole and CRS. Photographs are courtesy of N2Africa, ASHC and International Plant Nutrition Institute (IPNI).

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