Better soybean

through good agricultural practices

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For farmers in Zimbabwe

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 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. 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.

Variety	*Days to maturity*	*Growth habits*	*Disease susceptibility*	*Pest/diseases resistance*
1. SC Squire	125	Indeterminate	Susceptible to downy mildew, bacterial pustule, wildfire and frogeye	Highly resistant to rust, tolerant to red leaf blotch
2. SC Saga	126			Highly tolerant to frogeye leaf spot and rust
3. SC Serenade	126		Susceptible to rust	Very good tolerance to frogeye leaf spot
4. Safari	128		Highly susceptible to rust	High resistance to frogeye leaf spot, wildfire and downy mildew
5. Santa	126	Determinate		High tolerance to bacterial blight and red leaf spot
6. Siesta	125		Susceptible to red leaf blotch	Highly resistant to wildfire, downy mildew and frogeye leaf spot
7. Sequel	125			Highly tolerant to rust

**** It is recommended that varieties 1 to 5 grow in middleveld and highveld areas, while 6 and 7 grow in all regions.***

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.

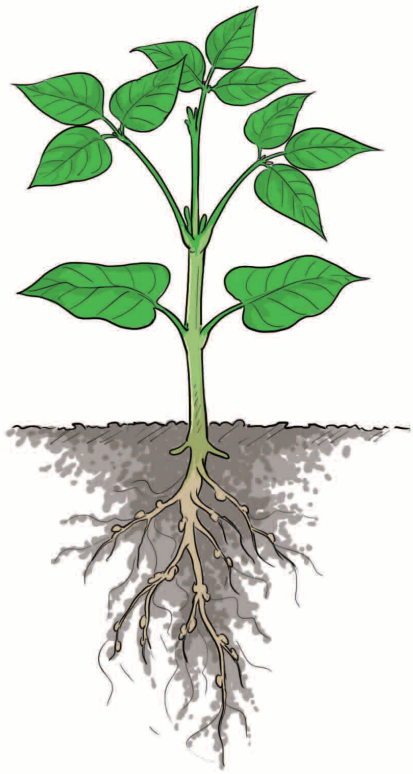
Step 3: Inoculation

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 rhizobia

1. Spread 100 kg of soybean seed on a clean plastic sheet or in a large container.
2. Mix 100 g of inoculant and 1 liter of water in a clean bucket.
3. Add 50 grams of sugar into the solution. The sugar acts as an adhesive between the seed and the inoculant.
4. Stir the solution for 30 seconds.
5. Sprinkle the inoculant mix onto the seed.
6. As you sprinkle the inoculant onto the seed, turn the seed gently to ensure that all seeds are coated with the inoculant. The coated seeds should look shiny wet.
7. Plant immediately after inoculation and protect the inoculated seed from direct sunlight by covering the container with paper, cloth or gunny bag.
8. Sow the seeds in moist soil and cover immediately afterwards to protect the rhizobia from sunlight.

Each inoculant packet is sufficient for 100 kg of seed. For smaller amounts of seeds, use 10 g inoculant (2 heaped teaspoons), 5 g sugar (1 teaspoon) and 100 ml water per 10 kg seed.



Important:

- The right inoculant must be used with the right legume. You should not apply, for instance, a bean inoculant on soybean seed.
- Inoculant contains living organisms that must be protected from heat and sun. Therefore always store the package in a cool place away from direct sunlight (for example, in a clay pot in the coolest place in the house).
- Inoculants lose their effectiveness when stored in an open package. Always store inoculants in their original package and use them quickly after opening the bag.
- Seeds should be coated with inoculant just before planting.
- Nodulation will fail if the inoculated seed is exposed to the sun for any length of time or is sown into dry soil and left for several days before irrigation/rain.
- Do not use inoculant after its sell-by date, as the inoculant may then not be effective anymore.

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 ammonium nitrate.
- Soybean needs phosphorus at planting. Good fertilizer types that supply phosphorus are SSP or Compound L.

Application

- Make a furrow of 5-7 cm deep. You will also use this furrow to plant soybean. 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. You can use a teaspoon or soda bottle-cap to measure the amount of fertilizer and apply it in the furrows, according to the distances in the table.
- When manure has been applied recently, rates can be reduced.

Fertilizer type	***Rate (kg/ha)***	***Row spacing: 50 cm***	
		In a furrow, spread 1	
		Teaspoon	Soda bottle-cap
SSP	225	Every 40 cm	Every 30 cm
Compound L	150	Every 65 cm	Every 40 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

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 45-50 cm apart. Within rows, plant seeds at 5-7 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 7-10 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. 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.

Product name	*Active ingredient*	*Use rate*	*Amount for one sprayer load (20 l knapsack)*	*For which type of weeds*
Dual Magnum	Metalochlor	1.1 l/ha	82 ml	Broad-leaved weeds and grasses
Sencor 480 SC	Metribuzin (triazine)	1.1 l/ha	75 ml	Broad-leaved weeds and some grasses
Lasso 48 EC	Alachlor	2.5 l/ha	75 ml	
Fusilade Super	Fluaziflop-p-butyl	1.5 l/ha	75 ml	Grasses and volunteer wheat
Classic	Chlorimuron ethyl	45 g/ha	5 g	Nutsedge and broad-leaved weeds

**** Dual Magnum, Sencor 480 SC and Lasso 48 EC are pre-emergence pesticides while Fusilade Super and Classic are post-emergence pesticides***

Pests and diseases

Insect pests

Common pests affecting soybean in Zimbabwe are aphids, the green stink bug, cut worms and snout beetles.

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.

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

Product name	*Name of active ingredient*	*Use rate (L/ha)*	*Amount for one sprayer load*	*For which pest*
Karate	Lambda-cyhalothrin	0.1	5 ml in 20 l water	Cutworms, bollworms, loopers
Fenvalerate	Fenvalerate	1	50 ml in 20 l water	Cutworms, flea beetles, bollworms, semi-loopers

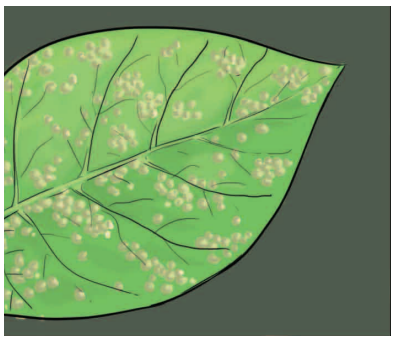
**** If unsure about how to manage pests, seek advice from an extension worker or agrodealer.***

Diseases

Soybean diseases can be caused by fungi, bacteria or viruses and can result in major yield losses. Common soybean diseases in Zimbabwe are mentioned below.

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.

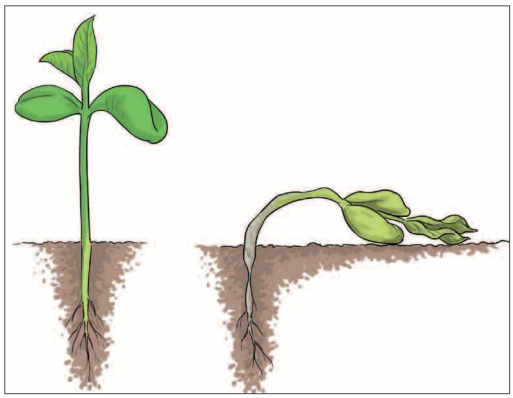


Soybean rust

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.

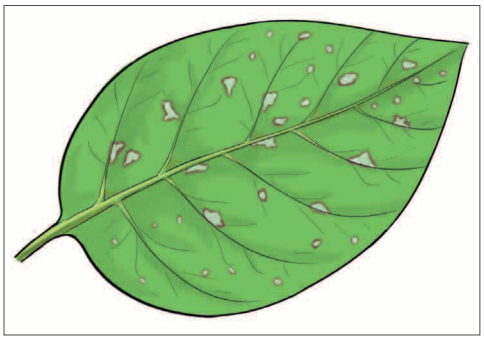
Downy mildew

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.



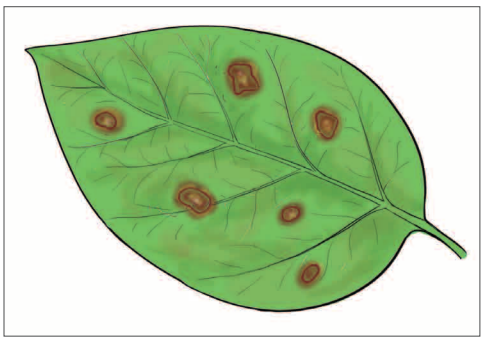
Damping off and anthracnose

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

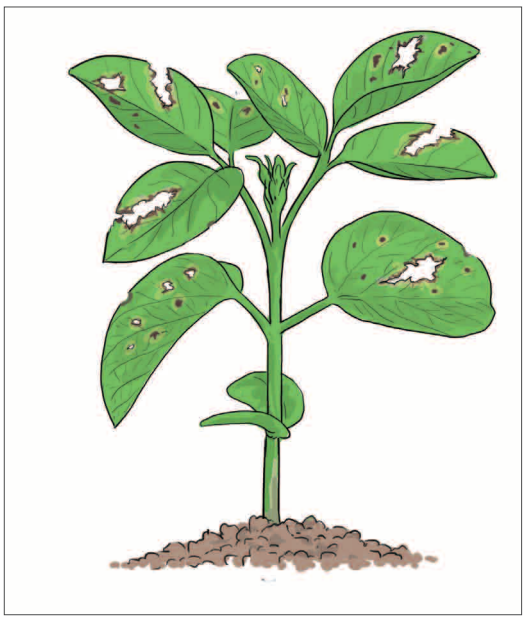
Red leaf blotch: In the first stage of the disease lesions appear on unifoliolate leaves associated with primary leaf vein. At this point the disease is easily confused with other diseases or cultural conditions affecting soybeans. Later, dark red spots on the upper leaf surfaces and similar spots with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



Read leaf blotch

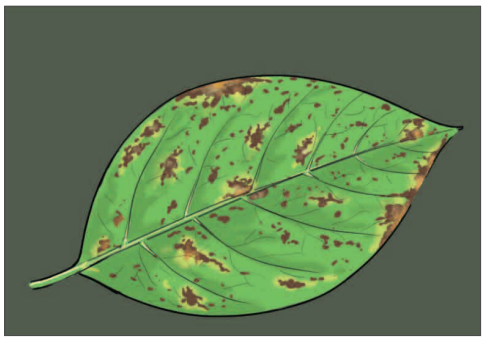
Bacterial diseases

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 built-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 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 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.

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 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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