

Technology brief for Soybean production in Tanzania

	Why grow soybean
Core	Nutrition - 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 livestock industry uses soybean for feed production.
Core	Market - It has a good market demand.
Core	Builds soil Organic matter - The crop residues are also rich in protein and are good feed for livestock or form a good basis for soil organic matter.
Core	Nitrogen fixation - 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 process 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 fixed nitrogen. In addition, soybean has the potential to control the parasitic weed <i>Striga hermonthica</i> .
Tip	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 enhances 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.
	Land selection and preparation
Core	Soybean can be grown on a wide range of soils with a pH between 4.5 and 8.5. Attitude from sea level to approximately 2000m Soybean grows better at a temperature between 21°C-32°C 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.

Core	
Tip	You can plant soybean on ridges or on a flat seedbed.
	Variety and seed selection
Core	Select a good soybean variety which suits your agro-ecological zone.
Core	<p>Maturity period - pay attention to the maturity period.</p> <p>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 give higher grain and biomass yields, fix more nitrogen and contribute more to soil fertility than early maturing varieties.</p>

<i>Variety</i>	<i>Grain characteristics</i>	<i>Potential 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	3-4	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	3-4	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	3-4	Indeterminate	Moderately resistant to other diseases, susceptible to soybean rust
Uyole soya 4	Colour: cream Size: large Oil: 35-40% Shattering: very low	2000-3000	4-5	Indeterminate	Moderately resistant to other diseases, susceptible to soybean rust
* <i>The seed rate for all the above varieties is 60-80kg/ha when manually planted but 80-100 kg/ha when planters are used</i>					

Core	<i>Use only high quality seed for planting.</i>
Core	<ul style="list-style-type: none"> • Make sure seed is not more than 6 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.
Core	<ul style="list-style-type: none"> • 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.

	Inoculation
Tip	<p>Soybean fixes nitrogen in its root nodules. Inoculate soybean seeds with registered rhizobia inoculants to ensure nodule formation.</p> <p>Always check you have the right inoculant for soybean since each legume crop needs a different type of rhizobium bacteria.. You will find directions for using inoculants on the inoculant package, or follow the instructions below.</p>
	<p><i>How to inoculate soybean using solid-dry inoculants (Legumefix)</i></p> <ol style="list-style-type: none"> 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. 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

Key Points to Note:

1. Once the inoculant package is opened, all contents must be used and not kept for reuse
2. Maximum storage period under farmers conditions (below 30 degrees celcius) for Legumefix inoculant is 2 years. Maximum storage period under farmers conditions (below 30 degrees celcius) for Biofix is between 6-8 months or check the expiry dates at the back of the package.

Facts about inoculants:

- ï The roots of legumes and rhizobium bacteria work together to biologically fix nitrogen. Inoculants contain the bacteria that

	<p>help the soybean to make nitrogen.</p> <ul style="list-style-type: none"> ï Inoculants are much cheaper than nitrogen fertilizer. ï 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. ï Inoculants lose their effectiveness when stored in an open package. Therefore do not open the package until you are ready to use it. ï Inoculants also lose their effectiveness when exposed to heat or direct sunlight. Therefore always store the package in a cool place in the house or a period of between 6-8 months. Also check the expiry dates at the back of the inoculant packet. ï Directions for using inoculants can be found on the package. <p><i>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. You can also contact the supplier through the contacts provided at the back of the packet.</i></p>
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	Applying fertilizer
Tip	<p>Important points</p> <p>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.</p>
Core	<p>Good fertilizer types for soybean that supply phosphorus are SSP, TSP, DAP or Minjingu Phosphate . However, SSP and TSP are not readily available in Tanzania. Choose Minjingu Phosphate when the pH of the soil is below 5.6.</p>
Core	<p>Application</p> <p>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.</p>

<i>Fertilizer type</i>	<i>Rate (kg/ha)</i>	<i>In the furrow, spread 1</i>	
		<i>Teaspoon</i>	<i>Soda bottle-cap</i>
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

	Planting
Core	<ul style="list-style-type: none"> • 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.
Core	<p><i>Spacing of mono-cropped soybean</i></p> <ul style="list-style-type: none"> • 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).
Core	<p><i>Intercropped soybean</i></p> <p>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</p>

	Field management																						
Core	<p>Weeds Control weeds to minimize competition for nutrients, water, sunlight and space. Weed control can be manual or chemical, or both.</p> <p><i>Manual weed control:</i> 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.</p> <p><i>Chemical weed control:</i> Herbicides, if used properly, are safe and effective in controlling weeds. There are different types of herbicides. The type to use depends on the predominant weed species and its availability.</p>																						
Tip	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.																						
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	Pests and diseases
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Core	<p>Insect pests Common insects affecting soybean in Tanzania are white flies, aphids, thrips, 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.</p> <p>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.</p>																
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	<p>Diseases Soybean diseases can be caused by fungi, bacteria or viruses and can result in major yield losses.</p>																
	<p>Fungal diseases <i>Soybean rust:</i> 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.</p> <p><i>Frogeye leaf spot:</i> 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.</p>																

	<p><i>Red leaf blotch:</i> 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.</p> <p>Other fungal diseases are <i>Downy mildew, Damping off and anthracnose, Cercospora leaf blight.</i></p>
	<p><i>Bacterial diseases</i></p> <p><i>Bacterial blight:</i> 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.</p> <p><i>Wildfire:</i> 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.</p>
	<p><i>Viral diseases</i></p> <p>Viral diseases can be transmitted by aphids, beetles and whiteflies. A common disease is soybean mosaic/bean yellow mosaic virus. 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.</p>
	<p><i>To control fungal and bacterial diseases:</i></p> <p>*Plant tolerant varieties.</p>

	<p>*To control rust, plant early.</p> <p>*Plant in a good seedbed and avoid poorly drained or compacted soils.</p> <p>*Rotate soybean with non-legumes to prevent the build-up of diseases.</p> <p>*You can treat seeds with fungicides (for example <i>Captan</i>, <i>Apron Plus</i> or <i>Thiram</i>, use 1 sachet/8 kg seed) for protection against soil-borne fungal diseases.</p>
	<p><i>To control viral diseases:</i></p> <p>*Plant tolerant varieties.</p> <p>*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.</p> <p>*Uproot and destroy affected plants. This can reduce the incidence of insect- transmitted viruses.</p> <p>*Control weeds in and around the soybean farms.</p> <p><i>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</i></p>
	<p><i>Safe use of chemicals</i></p> <ul style="list-style-type: none"> ï Use only herbicides, pesticides and fungicides that are recommended to soybean to avoid damage to the plant. ï 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. ï Do not store chemicals in the same place as food. ï Do not eat from the same spoon you used to measure chemicals.
	<p>Harvesting</p>

<p>Core</p>	<p>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. Pick the pod and shake. If seeds are detached from pod, the crop is ready for harvest.</p> <ol style="list-style-type: none"> 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 until dry; protect from rain and animals. Test the grain to see if it is dry enough by biting - grain should break or crack, not bend or stick between your teeth. 4. Winnow to remove chaff, dust and other rubbish. Also remove shrivelled, diseased, broken grains and grains of other varieties. Dry the grains for 3 days before packing. 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 <i>Actellic Super</i>. 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; by spraying the room with insecticides e.g. Actellic. 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. 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.
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Core

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.

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.

Soybean can make different products like soybean flours, cakes, milk, tofu, among others.

Ask an extension agent for more soybean recipes!