

# SOYBEAN

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## ECHO TECHNICAL NOTE

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### WHY GROW SOYBEANS?

The soybean (*Glycine max*) is one of the most important food plants of the world, and seems to be growing in importance. It is an annual crop, fairly easy to grow, that produces more protein and oil per unit of land than almost any other crop. It is a versatile food plant that, used in its various forms, is capable of supplying most nutrients. It can substitute for meat and to some extent for milk. It is a crop capable of reducing protein malnutrition. In addition, soybeans are a source of high value animal feed.

Nevertheless, the soybean is adapted primarily to the Temperate Zone. Each improved variety has an adaptation determined in large part by latitude. Soybean requires careful home processing to bring out its best qualities, and if not well prepared, it has an off-flavor that is seldom appreciated.

### CLIMATIC, SOIL, AND OTHER REQUIREMENTS FOR GROWING SOYBEAN

The soybean is a daylength sensitive crop. Length of daylight is the principle factor that affects the amount of vegetative growth before flowering begins. The ideal situation is that the plants grow to a reasonable size (2-3 feet) before they bloom. Large plants tend to bear a large number of seeds. Thus, seed yield potential per plant is closely related to the day length requirement of the variety and to the season of planting. It is recommended, therefore, that in the preliminary stages of developing soybean as a crop in a new region, several varieties be tried as well as several planting dates, and that careful notes be taken including planting date, date of flowering, harvest date, and number of seeds per plant.

Soybean is a hot weather crop suitable for year-round growth in most parts of the tropics. Temperatures of at least 15 degrees C are needed to germinate the seed and mean temperatures of 20-25 C to grow the crop. Soybeans need at least moderate soil moisture in order to germinate and for seedlings to become established, but need dry weather for the production of dry seed (note that fresh, green seed for immediate consumption can be produced during the rainy season). Soybeans suffer if the soil is waterlogged. Established soybean plants can withstand considerable drought.

Soybeans need to be inoculated with a particular strain of *Rhizobium* fungus before planting. This fungus fixes nitrogen (i. e. takes elemental nitrogen from the air and adds it to the soil in a form that the soybean plant can use). However, if soybeans are planted in a field that contained soybeans as a previous crop, they may not require inoculation because the *Rhizobium* will still be in the soil. If soybeans are not grown in association with *Rhizobium*, they will grow more slowly, require nitrogen fertilizer, and yield less. *Rhizobium* inoculum must be fresh (viable) and is usually purchased with the seed. If *Rhizobium* inoculum is not available in a particular area, and soybeans are not now being grown, it may be difficult to produce this crop.

Soybeans need fertilizer, including both the macronutrients phosphorous and potassium (P and K) and sometimes micronutrients. Nitrogen is not required if soybeans are properly inoculated. Soybeans need rather large amounts of phosphorous, calcium, magnesium, and sulfur. Minor elements are sometimes required. Soybeans cannot be recommended for unfertilized soils.

## CULTURE

Preplant Precautions. Crop residues in the field or after thrashing should be destroyed by feeding them to animals or them plowing under. Fields are often burned to remove weeds and reduce weed seeds. This will stimulate guinea and speargrass growth, however.

Seedbed Preparation. Trash, large stones, and large plants are removed from the field. It should then be well tilled to eliminate weeds and to break up large clods. Fertilizer is usually applied, usually ordinary superphosphate (not double superphosphate). While it is not practical to specify exact needs without previous trials, 100-150 kg/hectare of actual P<sub>2</sub>O<sub>5</sub> (phosphorous pentoxide) is a good beginning point. Determine the total amount from the percentage given on the bag.

Fertilizer can best be applied just before planting. Furrows are opened 60-90 cm. apart and 10-12 cm deep and the fertilizer is dropped into the soil and covered with 5-8 cm. (2-3 inches) of soil. Note that the higher rates of fertilization are for the close planting. It may be necessary to calibrate machinery for the fertilizer spreading, or if made by hand, to calculate the number of feet per handful. Manure can be used as fertilizer, added to the furrows in addition to some mineral fertilizer.

Planting. If soybeans are not grown in your country, you will need to purchase inoculum from elsewhere. Here in the United States inoculum can be purchased from almost any farmer supply store in regions where soybeans are grown. Because of the limited shelf life, however, it is only stocked during the spring and summer season when soybeans are being planted. It is quite possible that your planting season will be at another time of year. Therefore it is important to plan well ahead and order inoculum while it is available. ECHO does not sell inoculum.

The soil should be moist at the time of planting. Soybean seed should be dusted with inoculant and, if experience shows the need, with a seed protecting chemical permitted by the country. Remember to protect yourself and workers against such poisons. The seeds are planted by machine or by hand 4-5 cm apart in the row. They are covered with 3-5 cm. (1 and 1/4 to 2 inches) of soil. Sixty to seventy kilograms of seed are needed per hectare. If moisture is sufficient, the seeds will germinate in 3-4 days.

Varieties. Some of the important differences among soybean varieties are day length response as previously discussed, resistance to disease, and yielding ability. In a new area, one may not be aware of the particular disease problems that are present, nor is one likely to obtain quantities of adapted soybean seed easily. Therefore a variety trial is suggested. The International Soybean Center (INTSOY) at the University of Illinois groups soybeans according to adaptations to tropical, subtropical or temperate climates.

At the higher elevations in the tropics where the climate is mild, should one use temperate varieties and at intermediate elevations subtropical varieties? Perhaps, however, daylength is likely to be a more significant factor

than temperature. Also daylength and temperature differences sometimes interact in unpredictable ways. Our recommendation is that in such locations one needs to do a larger variety trial that includes a few varieties from each of the three regions. Remember too that precise predictions based on elevation alone are impossible. This is because at a given elevation the climate will be progressively milder as one goes farther from the equator.

With some hesitation, a list of varieties is given below, but be aware that there are many others. When ECHO has seed it may or may not include these varieties.

#### Some Good Soybean Varieties

Tropical	Subtropical	Temperate
Duocrop	Davis	Chico
Jupiter R	Duocrop	Dawson
SantaRosa R	Santa Rosa R	Epps
Supreme	Supreme	Pershing
UFV-1		

Diseases & Pests. Soybeans, once planted, require a minimum of care. Weeds will often be a problem and are best controlled by adequate soil preparation and keeping fields free of weeds for 4-6 weeks before planting. Specific herbicide for control of grasses may be used. Broad-leafed weeds must be controlled mechanically. After germination of weeds, mechanical cultivation with a tractor-drawn cultivator or hoe can be done with much care to avoid damage to the plants. Mulching is sometimes practiced, but may not be practical.

Diseases of soybean are best avoided by using disease resistant varieties when available, or by improved field practices such as elimination of plant residues and rotation of fields. In general these techniques are useful for insect control as well.

Viruses for which there are no controls sometimes infect soybeans. Reduce some seedborne viruses by use of clean seed. Keep other leguminous crops and weeds away from soybean. If practical, control the disease vectors (insects that carry the virus, such as aphids and white flies).

Fungal diseases are most common under wet conditions. Use clean seed, a chemical treatment, and resistant varieties. Resistant cultivars are available for leafspot (*Cercospora*) and tolerant cultivars for Target Spot (*Cormiospora*). There is no control of rust (*Phakopsora*), a disease present only in the Eastern hemisphere. A bacterial disease, pustule (*Xanthomonas*) is controlled by using disease-free soil, control of residues, and resistant varieties.

Insect pests are highly location-specific. Some possible pests and their control are mentioned below:

- Aphids: biological or chemical control
- Beetles: highly varied, some may be difficult to control
- Flies and moths: highly varied

Pests are likely to be few when soybeans are grown the first time. They are likely to increase, as soybeans are grown continuously, or over a wider area. The insect and disease problems that occur are best dealt with individually when encountered.

## HARVEST & STORAGE

Soybean seeds have a relatively short storage life. In order to obtain a maximum life, soybeans for seed should be grown under excellent conditions and should mature during dry weather. Pods should be permitted to dry as much

as possible in the field before harvest. Once the pods are dry, they should be harvested by hand or machine. Further drying of the plants in the sun facilitates thrashing. Thrashing is done by hand by flailing (beating) or by machine. Even after thrashing, further drying may be necessary. This is usually done on a floor (concrete slab) where the beans are turned regularly. Farmers who have produced coffee should know the details. Once the seeds are dry and before their storage, much trash and dust can be removed by sieving over hardware cloth.

Dry soybeans are best stored at a cool temperature in sealed containers. They can be stored in a household refrigerator. Most soybeans for field planting are not stored for more than one year. In hot, humid climates with poor storage facilities, the viability of the soybeans may drop considerably before the next planting season. Danny Erickson with INTSOY says that he has seen viability drop by 50% in just three months. He reports that smaller seeds tend to have a longer storage life under such conditions, so you might want to consider storability when making your final variety selections. Proper storage also maintains quality for foods made from soybeans.

Normally there are no insect problems in storage, but stored soybeans should be frequently observed. If soybeans become moldy they are too moist and need better drying.

### **PRINCIPLE USES OF SOYBEAN**

Shelled Green Seeds. The fully developed pods while still green are harvested for their green seeds. These are removed by hand and then boiled until tender. An alternative technique is to boil the pods first and then shell the beans. The cooked beans can be eaten as they are, or combined in many dishes. Their flavor is unique but very good.

Preliminary Boiling Of Dry Seeds. Normal boiling of soybeans as done with most kinds of dried beans results in an off flavor (enzyme-substrate reaction) that many people do not like. The following technique avoids this reaction by destroying the enzyme by heat and is a basic technique for several other foods. Bring to boiling two parts of water. Add one part of soybeans and boil five minutes. Meanwhile, boil 4 parts of water. Remove the seeds from the first water, rinse them, and boil them in the second water for five minutes more. Discard water and rinse again. Note that this product will be called preboiled soybeans.

Boiled Soybeans. Boil preboiled soybeans until as soft as desired. This product can be used as soft, cooked beans, soup, or as a mashed paste.

Soybean Pulp. Boil as above until very soft and mash. Use this to enrich baked products.

Soybean Nuts. Deep fry preboiled soybeans about 12 minutes at 350 degrees F. Drain. Salt as desired. Use this as a snack.

Soybean Sauce. Cook preboiled soybeans 2 hours with spices to consistency desired to form a sauce for use with other dishes.

Soybean Milk. Grind preboiled soybeans as fine as possible. This can be done with a home blender, a hand mill, or an electric mill. The ground soybeans should be low in grittiness. Mix one part ground, preboiled beans to two parts water. Filter with cloth or colander. The liquid is left to stand one hour and is then decanted or filtered. The liquid portion is then boiled gently for one hour. This is soybean milk.

Fried Bean Cake. The residue from filtering (or the precipitate from letting the filtrate settle) can be used for fried bean cake. Mix 4 parts residue with 1 part flour. Fry slowly in an oiled frying pan.

Cheese (Tofu). Soak beans (not preboiled beans) overnight in water. Discard water and rinse. Grind as fine as possible (see above). Mix three parts water to one part ground soybean. Filter through a cheesecloth. Heat to

boiling, stirring to avoid scorching. While the milk is still boiling, add one part of a precipitating solution as follows:

1% solution of MgSO<sub>4</sub> (Epsom salts) -- One part solution to 8 parts milk,  
or  
vinegar -- One part solution to 66 parts milk.

Curd formation occurs immediately. After 15 minutes filter through cheesecloth, discarding the solution. Wash curd twice. Press to shape and to remove water. Use this as a cheese substitute in cooked dishes.

Other Products. Soybean sprouts are made by germinating the seeds. Tempeh is fermented soybean mash. Several oriental sauces are made from soybean. High protein flour can be made after defatting, but this is not practical at the low technology scale. (Instead, use soybean pulp previously described). There are hundreds of uses for this versatile food. ECHO's files contain other techniques and recipes. One organization has had considerable success in introducing soybeans, their technology and their products to the tropics. If you are serious, it would be useful to write to them. (PLENTY USA, Box 90, Summertown, TN 38483)

#### NUTRITIONAL VALUE OF WHOLE SOYBEAN

Soybeans are the most highly nutritious legume seed, and rival milk and meat in food value. The protein is of high quality but lacks a sufficient amount of the essential amino acid methionine to balance it. (This is the case with all legumes). Thus, it is a perfect complement for maize (corn) protein, which has a considerable amount of methionine but is itself lacking in another essential amino acid, lysine, that is abundant in soybeans.

Soybean oil contains a large percentage of non-saturated fatty acids. The total yield of these nutrients and B vitamins per acre of land is very high and difficult to surpass. Thus, soybean is perhaps the most nutritious crop one can grow. Note that soybeans are poor sources of vitamins A and C, of most minerals, and of starch.

Product	Protein	Oil	Fiber	Moisture
				%
	g/100g			
Uncooked whole	33.0	9.7	6.5	11.9
Cooked whole	11.0	5.7	10.8	72.0
Soy milk	2.7	1.0	0.0	96.2
Bean cake (residue)	24.0	15.2	14.5	76.8
Tofu	7.8	4.2	2.4	85.0

Note that about 3/4ths of the soybean protein and 55% of the fat is recovered in soybean milk. Almost all of the rest is recovered in the cake.

#### SEED AVAILABILITY

ECHO currently only has seed of the variety 'Wright', a temperate variety.