Pulse Crops

- Book Review: Food Legumes (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Book)
- Drought-Tolerant, Early-Maturing 'Crimson' Lentil (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Drou)
- "Sweet" Lupin (Lupinus albus) Seed (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Swee)
- Marama Bean, Tylosema esculentum, for Very Arid Regions (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Mara)
- Nutritive Value of Nunas (Popping Beans) (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Nutr)
- Research on Nunas (Popping Beans) (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Rese)
- Pigeonpea Varieties from ICRISAT (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Pige)
- Soybean Crop Production Bulletin Available from ECHO (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Soyb)
- Tepary Beans Resist Drought (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Tepa)
- Causes of Bean Blossom Drop (https://www.echocommunity.org/resources/b6484ca2-6ccb-458c-b837-a9565ae7514b#Caus)

FOOD LEGUMES (1979) is an exceptionally useful book to which we frequently refer. We turn several times each month to this 435-page book to find alternate names, main uses, preferred climate, possible toxicity, etc. Let us look at Vigna unguiculata (cowpea) for an example of their treatment. Seven major common names and three botanical names are given at the top, followed by 119 other common names and the countries where these names are used. The next 14 pages cover a detailed botanical description, origin and distribution, cultivation conditions, planting procedure, pests and diseases, growth period, harvesting and handling, primary

product, yield, main use, subsidiary uses, secondary and waste products, special features, processing, and products and trade, followed by 13 pages of bibliography.

Twenty-seven legumes are covered: adzuki bean, asparagus bean, bambara groundnut, broad bean, chick pea, cluster bean, cowpea, grass pea, haricot bean, horse gram, hyacinth bean, jack bean, Kersting's groundnut, lentil, lima bean, moth bean, mung bean, pea, pigeon pea, rice bean, runner bean, sword bean, tepary bean, urd bean, velvet bean, and winged bean. No charge is made for single copies requested by government, research, educational, or and non-profit groups in countries eligible for British Government Aid (most developing countries). Write on official letterhead. Available to others for œ15 including surface postage. Order from Publications Distribution Office, Natural Resources Institute, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK; phone 44-1634-880088. (https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch3pul.htm#Table)

DROUGHT-TOLERANT, EARLY-MATURING 'CRIMSON' LENTIL. The *Arid Lands Newsletter* of the University of Arizona recently featured the new 'Crimson' variety of lentil *(Lens culinaris),* now available to farmers in the U.S. This particular variety is derived from Egyptian germplasm and is particularly well adapted to low rainfall, an early bloomer, tall and upright in growth habit, and a good yielder. Pods contain 2 or 3 seeds, seed coats are light brown with some darkly mottled spots, cotyledons are bright red-orange. The USDA registration article states that "these seed quality traits are distinguishing features of the cultivar and should appeal to international markets." In field trials no serious insect or disease problems were noted. Write ECHO if you would like a trial packet. (https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch3pul.htm#Table)

"SWEET" LUPIN *(LUPINUS ALBUS)* SEED. Dave Sweere and Gary Riestenberg with the United States Agricultural Development Corporation contacted ECHO and offered us seed of "sweet" lupin. The following is based on material written by Drs. Fred and Nancy Elliott, who developed the varieties for the company. Most North Americans know lupins as an ornamental or as a wildflower in the Rocky Mountains that can make cattle and sheep sick. But Europeans know it as a commercial crop which, for generations, has provided nutritious feed for their farm animals. In the South American Andes, people have eaten a lupin called tarwi for centuries. Lupins contain alkaloids, which cause a bitter taste and toxic effect when eaten. Andean people soak the beans for several days in running water to remove the alkaloids, then make a gruel which is often fed to babies or into a flour used in many breads and noodle recipes. The same procedure was described by Florentinus in 218 A.D. and is still used in Egypt and Italy to prepare lupins for animal feed. Lupins were grown for human and animal food centuries before Christ. The Roman author Varro reported that every Roman inn had a "labrum lupinarum," a basin used to soak out the alkaloids.

In this century "sweet" varieties of lupins have been developed which lack the bitter alkaloids. In many countries these are (/resources/79a84d02-a862-4399-b511-d58172338339)now grown like soybeans. The quality of the protein is similar to the soybean. In the processing of soybean meal the oils are removed and the meal is heated to inactivate the trypsin inhibitors and other compounds that inhibit

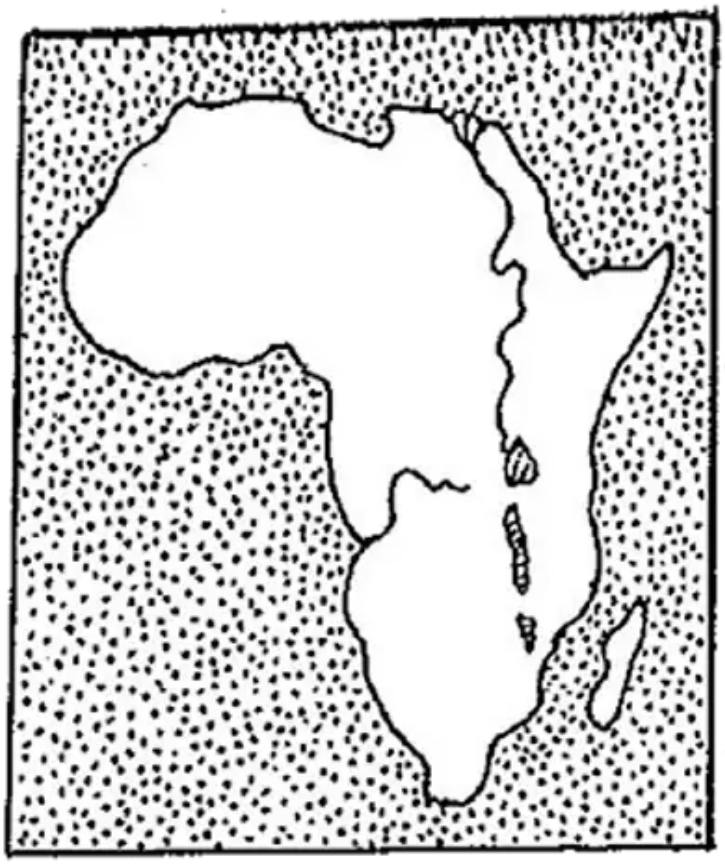
digestion. Such processing is not necessary with the sweet lupins. They can be fed directly to animals, including poultry, pigs, cattle and sheep. Because no heat treatment is needed they are a natural for the small farmer in remote areas. Getting enough protein to maintain good egg production is often a problem. Dr. Elliott says that studies at the University of Minnesota and Tufts University indicate that lupins can provide an adequate poultry diet.

Another advantage over many legumes is that the lupins do not produce gas in the intestines (technically one says they do not produce flatulence). Many beans contain the complex sugars raffinose, stachyose and xylose which are not digestible by humans and many other animals. However, after they have moved into the intestine they are attacked by microorganisms which can break them down. In the process they produce gas. This could be a special consideration if you are looking for a legume to put in baby food. Gerry sent us several kinds of pasta that they sell commercially (too early for a report on taste). Their recipes are proprietary, but he suggested that up to 30% lupin flour could be used.

Who should try lupins? Lupins would be a good crop to try at higher elevations, depending on your latitude. The book Food Legumes says that they are successful in Kenya between 5000-8000 feet (1500-2400 meters). In fact they can tolerate temperatures down to 16Ã¸F (-9Ã¸C). The tropical lowlands would not be suitable for lupins because the seeds will not set if the temperature is high during flowering (over 90Ã¸F or 30Ã¸C). Farmers can grow a crop of lupins in the cool season and, because it is a legume, it will add nitrogen to the soil for the next crop. Lupins may be thought of as suited to the more northerly parts of the temperate region. This is

because breeders have had success in adapting them to cold regions. Remember, though, that they originated in the Mediterranean. The variety ECHO was given should be one of the more adaptable. The same book says that this particular species (there are several other species) will tolerate mildly acid to mildly alkaline soils of only moderate fertility. They have been grown on saline (i.e. salty) soils in the Sudan and Egypt. I asked whether it would work to save your own seed. The answer is a qualified yes. Every time you grow the crop, roughly 2-10 plants per thousand mutate back to the alkaloid type. Because this is a dominant trait, the quality gradually diminishes. Gerry says that this variety, "altra," is one of the more stable. They have had excellent results through 7 years and expect they can go for 14 years. They have a clean-up program in which a large number of people go through one of the smaller fields tasting a seed from each plant. If the taste is bitter the plant is pulled out. The harvest is then used to start a new lot of seed that can be increased for about 10 years. You could either buy new seed every so often or go through the same exercise yourself.

MARAMA BEAN, *TYLOSEMA ESCULENTUM,* FOR VERY ARID REGIONS. Thanks to several people in ECHO's network, we are able to offer marama bean seed to those working in very arid regions. But what is a marama bean? I rely on



(/resources/5993f222-f50e-4ba9-888e-399b2bd1c4ad)the book Tropical Legumes: Resources for the Future for the following discussion. It is a wild plant prized by people living in and around the Kalahari in southern Africa. In Botswana and Namibia it is an important part of the diet in remote regions. It is a rich source of protein and energy in regions where few conventional crops can survive. It grows in some areas that receive up to 800 mm rainfall (32 inches) and in others where rainfall is so slight and erratic that in some years almost no rain falls at all.

The plant has long viny stems, but it is a creeper rather than a climber. They hug the ground, presumably avoiding drying winds. Seed pods contain 1-6 seeds about the diameter of a thumb nail. They are never eaten raw. After roasting they have a delicious nutty flavor that has been compared to roasted cashew nuts. Europeans in southern Africa grind the roasted seeds and use them as a culinary substitute for almonds. Africans boil them with cornmeal or grind them to a powder that is boiled in water to make either a porridge or a cocoa-like beverage. Raw seeds store well and remain edible for years. Protein content of seeds range from 30-39% (comparable to soybean). Oil content is 36-43% (about twice that of soybean). Like other legumes, the protein is rich in the amino acid lysine (5%) and deficient in methionine (0.7%).

During cooler months stems die back, but the underground tuber produces new stems when warm weather returns. The tuber can attain a weight of over 10 kg after a few years. (The plant at ECHO produced a tuber larger than a basketball.) Young tubers are dug in the Kalahari at about 1 kg. Tubers more than 2 years old are fibrous and/or astringent. Baked, boiled or roasted they have a sweet, pleasant flavor. They contain up to 90% water (important to surviving the dry periods) and are an important emergency source of water. [A bit of trivia: I have been told that it is the tuber from which water is squeezed in the movie "The Gods Must Be Crazy."] Tubers contain 9% protein on a dry weight basis. Tropical Legumes states that "of all the plants described in this book, the marama bean is perhaps the least developed" in scientific study or plant breeding efforts to improve it.

Dr. Stanford sent the following hints on germinating the seeds. Keep them warm (they come from the Kalahari Desert). Seeds germinate after a rainstorm has swept the land, and the soil has moistened deeply, but the surface is drying. The thick shell, almost 1 mm, is extremely hard. When wetted, it swells tremendously. Then the germ and endosperm will absorb water, and germination starts. But for that to occur, you must first scratch the outside with a file. Do NOT try to hasten germination by dropping the bean into water. Be patient--let it imbibe slowly by planting it in moist (not wet) soil or potting medium. Plants prefer neutral to acid soil or sand.

Galen Sauder in Botswana supplied us with some seed and wrote, "I was excited to receive your request for marama beans. The day before it arrived I was helping some people harvest these beans. They were growing by the side of the road in an area that had received rains. I could have filled my pick-up if I had all day. The beans seem to like the gutters of the road where water collects. Last year I had some of these beans. After they were roasted the woody shell cracked off and inside is a delicious nut tasting like a hickory smoked cashew."
(https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch3pul.htm#Table)

NUTRITIVE VALUE OF NUNAS (POPPING BEANS). An article by van Beem et. al., in the April-June 1992 issue of Economic Botany addresses this topic. But first, what are popping beans?

Nunas are varieties of (American) common beans, *Phaseolus vulgaris,* which burst when toasted. In spite of the common name "popping beans," they do not actually pop. Rather, when heated in hot oil or on a hot dry pan, they expand and split open.

This is all the cooking they require. "The resulting product has a powdery texture with a taste between that of popcorn and roasted peanuts." Most of our staff very much enjoyed the very few beans that we could spare for eating as a snack.

Nunas are cultivated in the highlands of Ecuador and Bolivia between 2,000 and 3,000 meters. In regions where firewood is scarce, the benefit of these beans obviously extends much beyond their unique taste. Most beans must normally be boiled for a long time to be adequately softened. This time is even longer in the mountains where the boiling point of water is well below 100 deg.C. Nunas require only 3-4 minutes of cooking.

The plants are the "pole bean" type. They seem to be susceptible to common bean diseases. We can only keep the plants (/resources/f65d1849-17fb-4da7-b3ca-61d6bd4ddfca)alive in the winter months here in southern Florida, so I doubt very much if you would succeed with them in any area where common beans do not grow well. They are also daylength sensitive. ECHO sent seed to several gardeners across the United States. Although the plants often did well, they bloomed and produced only in those few locations where they were still alive in late fall and winter when the days were short.

"The unique texture and taste of popped nunas appears to be related to their high starch content. The high starch levels may also explain the 'filling effect' [appetite satisfied] nunas have after consuming 15-20 seeds, as bean starches have been reported as being less digestible than cereal starches." [Ed: His thinking may be that materials that cannot be digested remain longer in the gut so the person feels full.]

There is no difference in moisture content between nunas and other common beans, but in nunas there is less space for steam to diffuse upon heating. "The steam forced expansion of these [limited] spaces is thought to contribute to the popping mechanism." Protein content is slightly lower in nunas than in other common beans (20.0% vs. 22.2%); starch (40.9% vs 35.5%) and amylose (18.1% vs 17.2%) are higher. The percentage of protein which can be digested was slightly lower in popped than in boiled nunas (76.6% vs 79.1%). "Nunas stored at optimum conditions retain indefinitely their ability to pop. However, under market place conditions, nunas lose their popping ability 2-3 months after harvest due to seed hardening. ... shop owners then will try to sell them as a dry bean cultivar. However, when nunas are boiled, they take a long time to reach an edible state and the broth in which they are cooked is 'watery' when compared to the thick broth of dry bean varieties."

The authors were concerned as to whether the short cooking time might be inadequate to destroy the antinutritional factors in common beans, especially tannins and lectins. Tannin levels in beans are low, though they do slightly reduce digestibility of protein. Lectins, the principle toxins in common beans, are more worrisome, as they interfere with absorption of nutrients from food. Lectins are themselves proteins, comprising about 10% of the total bean protein. Fortunately lectins appear to be denatured by the higher temperatures of roasting because popped beans had a similar or lower level than boiled beans.

Individuals working in areas where common beans are an important crop might well want to take a look at nunas.

They probably have some export potential to the States because of the publicity they have received in recent years and the limited locations where they can be grown. In fact, one variety of seed that we are offering we purchased from a health food store in California. If you work where these beans are common and have helpful insights (especially as to how varieties may differ from each other), please write. These have grown very vigorously at ECHO through the years.

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RESEARCH ON NUNAS (POPPING BEANS). The international research center CIAT in Cali, Colombia is working (on a small scale) with nunas. Dr. Jeffery White, CIAT bean physiologist, says the beans do not produce well and are susceptible to most bean diseases, so farmers grow them less and less. "In fact, the crop is probably disappearing." Dr. Julia Kornegay at CIAT has crossed popping bean varieties with disease-resistant common beans and sent the progeny to Peru for testing. But when crossed with ordinary beans, the offspring lose their popping ability. Special breeding techniques are needed to recover that trait.

"There are about 30 types of nunas that differ in seed size, shape and color, but all taste similar. ...They retain their popping ability for years if stored at low temperature and low humidity. But they lose the popping trait in a few months if stored improperly." Dr. Kornegay would like to see popping beans marketed internationally. (https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch3pul.htm#Table)

PIGEONPEA VARIETIES FROM ICRISAT. We often tell people that ECHO specializes in growing food under difficult (/resources/8f26dab3-ff88-4eb7-8e86-3ffaec03522f)conditions. The pigeonpea, *Cajanus cajan,* is a prime example of a tough but nutritious plant for just such cases. This article is directed toward two audiences. For some of you, pigeonpea is already an important crop. You will mainly be interested in the information about and seeds for the vegetable pigeonpea varieties. For others who are not familiar with pigeonpea at all, the general discussion of pigeonpea is for you.

THE PIGEONPEA. (The following information is gleaned from a very helpful book, Pigeonpeas: a Valuable Crop of the Tropics, by Julia Morton, Roger Smith, A. Lugo-Lopez and R. Abrams, available for about US$7 from Dr. Eduardo Schroder; BNF Laboratory; Dept. of Agronomy and Soils; Univ. of Puerto Rico; Mayaguez, PR 00709-5000. They also have a similar book on mung beans at the same price.) Why might you wish to grow pigeonpeas? I think of three principal reasons. (1) They grow under poor soil conditions. (2) They are tolerant of dry weather. (3) They are a nutritious, high-protein pulse crop. Other reasons include: (4) Leaves can be used for animal feed. (5) The fast-growing plants make good shade for other crops, e.g. vegetables, herbs, vanilla. (6) Plants are perennial for up to 5 years. (7) Woody parts can be used for firewood. (8) Water and nutrients from deep in the soil can be caught by its deep taproot.

The pigeonpea is a shrub that grows from one to a few meters tall and perhaps two meters wide, unless special short-season varieties are chosen. Most types flower when the days are 11 to 11 1/2 hours long, but varieties responding to both shorter and longer day lengths are available, and some will flower at any time of the year. Usually flowering begins in 120-150 days and seed maturity in 250 days, but these figures can be as early as 60 and 100 days respectively.

It is often advisable on a small farm to have one area for higher value crops, where the soil has been improved by concentrating the limited amount of manure and mulch, and where some irrigation is available. On the remaining, larger part of the farm, plants which yield in less fertile soil and require only normal rainfall are desired. Plants such as cassava, sweet potato and pigeonpeas fall into this later category. A few pigeonpeas are also often grown near the house for ease of harvest. For household use "indeterminate" varieties are wanted because they will produce a few pods each day over a long season. I recall visiting a dry part of the Dominican Republic during the dry season. Very little was green in the gardens, but pigeonpeas were green and providing a small daily harvest. They do best where annual rainfall ranges from 500-1,500 mm (20-60 inches) a year. The range of suitable elevations depends on latitude. In Venezuela they are grown up to 3,000 meters, in Jamaica up to 1,100 meters. In Hawaii they failed to set seed at 1,000 meters.

"When cultivated for the seeds, pigeonpeas are grown as an annual or biennial because the productivity declines after the first year and drops considerably after the third year. When grown for forage or green manure, it is usually maintained no more than five years. The plant will die in about 10-12 years."

"No regrowth occurs when plants are cut off at ground level, but regrowth is satisfactory with cutting heights ranging from 0.15 to 1.5 meters. Vigor declines and plant mortality increases somewhat after a first cutting and more markedly after a second cutting."

"The pigeonpea is noted for greater soil adaptability than other legumes [nitrogen fixing plants]. ... It performs well in a wide range of soil types. It can endure soil salinity of 0.0005 g NaCl/g. It seems well adapted to a soil pH as low as 5 and as high as 8." Plants also are rather resistant to nematodes.

VEGETABLE PIGEONPEA. (The following is taken from a booklet by the same title by ICRISAT, the International Crops Research Institute for the Semi-Arid Tropics, Pantancheru, Andhra Pradesh 502 324, INDIA. The booklet has four interesting and complicated recipes which are in the Indian tradition.)

Pigeonpeas are most commonly used as a pulse crop. (Pulses are leguminous crops, the dried seeds of which are used as human food.) When used as a "vegetable," the pea is picked when the seeds have reached physiological maturity, that is, when they are fully grown but just before they lose their green color. At this stage the green seed is more nutritious than the dry seed because it has more protein, sugar and fat. In addition, its protein is more digestible. "There are considerably lower quantities of the sugars that produce gas (flatulence) in the green seeds." The dried seeds contain somewhat more minerals. See Table I.

Table I. Comparison of some nutritional constituents of green and mature pigeonpeas on a dry-weight basis.

Constituent	Green Seed	Mature Seed
Protein (%)	21.0	18.8
Protein digestibility(%)	66.8	58.5
Trypsin inhibitor (units/mg)	2.8	9.9
Starch (%)	44.8	53.0
Starch digestibility	53.0	36.2
Amylase inhibitor (units/mg)	17.3	26.9
Soluble sugars	5.1	3.1
Flatulence factors(g/100g sol. sugar)	10.3	53.5
Crude fiber(%)	8.2	6.6
Fat (%)	2.3	1.9
Minerals and trace elements(mg/100g)		
Calcium	94.6	120.8
Magnesium	113.7	122.0
Copper	1.4	1.3
Iron	4.6	3.9
Zinc	2.5	2.3

In comparison with green peas, the vegetable pigeonpea takes longer to cook and is not as sweet, but is much more nutritious. On a fresh weight basis, it has greater edible portion (72% vs 53%), more protein, carbohydrates, fiber and fat than green pea. It also has more minerals and much more of some vitamins (469 vs. 83 vit. A/100g; 0.3 vs. 0.01 vit. B2; 25 vs. 9 vit. C).

"The best vegetable pigeonpea cultivars have long pods, with as many as 9 large sweet seeds which are easily removed from the shell." Sweetness is also desirable. In contrast, what is usually sold in Indian markets for use as a vegetable are small pods with small seeds. "Consumers prefer vegetable pigeonpea with green pods, ... but tests ... have shown that differences in pod color are not related to cooking time, taste or quality." However, cultivars grown from white seeds leave clear rather than colored cooking water. The large pods are especially attractive to insects. Insect damage can also be greater in cultivars that have the pods clustered in bunches at the tops of the plants, but these varieties are also shorter and are easier to spray with insecticides and easier to harvest. If the rainy season is long, or the field is irrigated, pods may be produced as long as the plant remains free of disease and the mean temperature remains about 15-30 degrees C. A yield of 11 t/ha of green pods in five pickings was obtained on one plot. Harvest the pods just before the seeds start to lose their bright green color. Because pod color at this stage will be different with different varieties, you will need to sample seeds to find when it is best to harvest. In the Caribbean, harvesting has been mechanized by adapting green bean pickers.

If you would like to try pulse-type or vegetable pigeonpea, ECHO can send you a small variety trial. If you are already familiar with pigeonpea and wish to do a major trial, write to ICRISAT; Patancheru, Andhra Pradesh 502 324, INDIA, and tell them details of the trial you intend to undertake.
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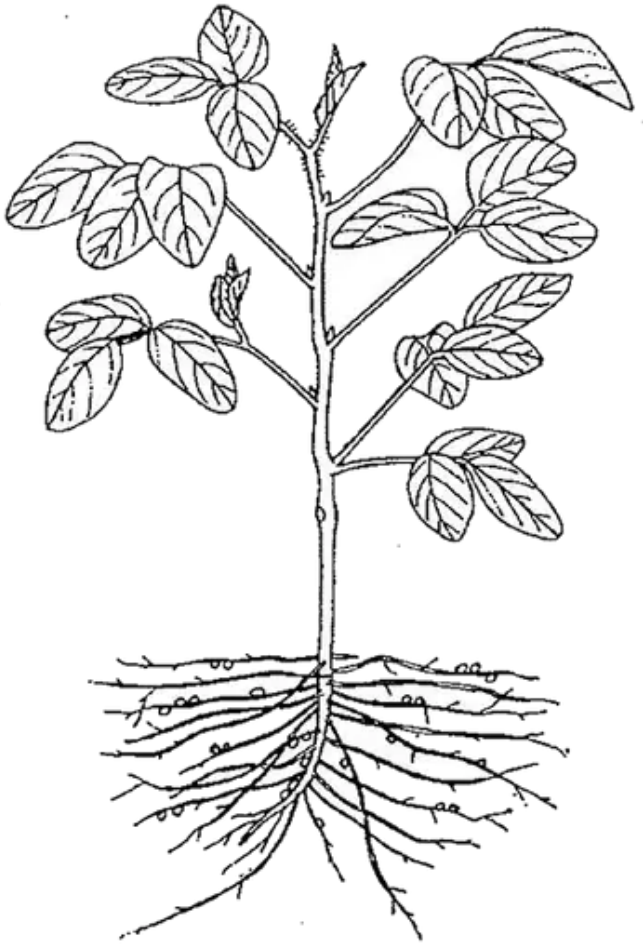
SOYBEAN CROP PRODUCTION BULLETIN AVAILABLE FROM ECHO. Dr. Frank Martin wrote this bulletin because soybean is one of the most important food plants of the world and is growing in importance in Third World countries. It produces more protein and oil per unit of land than almost any other crop and can substitute for meat and to some extent for milk. In 7 pages he discusses cooking/processing methods, climatic and soil needs, varieties and their differences, care of seed, and culture of soybean. (Write ECHO to receive the complete bulletin.) Many of you no doubt share my skepticism as to whether you would personally enjoy eating soybean and whether it would be accepted in your community. Yet I have seen examples where it has become much appreciated in a new community. The trick is that soybean must have special processing and be used in special ways. Here are some basic processing methods from the bulletin.

SHELLED GREEN SEEDS are boiled until tender (boil pods first for easier shelling). Cooked beans can be eaten as is or used in other dishes. Frank describes their flavor as "unique but very good."

PREBOILED BEANS. Normal boiling of dry soybeans results in an "off flavor." This can be avoided by destroying the enzyme that causes the problem by preboiling the beans. Bring to a boil two parts water, add one part soybeans and boil for 5 minutes.



(/resources/e96cdba1-8bc9-49d1-9002-c4d801a06491)Meanwhile, boil four parts water. Remove seeds from the first water, rinse, and boil in the second water for 5 minutes. Discard the water and rinse. These are called "preboiled soybeans."

BOILED SOYBEANS are made by boiling preboiled beans until soft. Use as desired. Alternatively the soft beans can be mashed and used to enrich baked products.

SOYBEAN NUTS are made by deep frying preboiled soybeans for 12 minutes at 350 deg.F. Drain and salt.

SOYBEAN MILK. Grind preboiled soybeans as fine as possible, using 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 a 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 cheese cloth. 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 MgSO4 (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.

ECHO sometimes has seed of the soybean varieties Davis (subtropical) and Duocrop (tropical) mentioned in the Soybean Crop Production Bulletin. We also have two other subtropical/temperate varieties developed for the southeastern United States, Braxton and Wright. We can send only enough to see how a small row will perform. If you are at low to moderate latitudes in the tropics, request Duocrop; at high elevations or in the subtropics request the other three.

If soybeans have not been grown in an area before, it is more important than with some legumes that the seeds be inoculated with rhizobia. Without this they may be inefficient at fixing their own nitrogen. ECHO does not carry inoculants; we refer you to the Haile-Dean Seed Co., P.O. Box 1458, Winter Garden, FL 32787, USA; phone 800/423-7333. They generally have bulk inoculant year-round, as they supply many tropical regions. If you start growing soybeans, finding inoculant may be a big problem for many of you. The good news is that a little bit goes a long way (a small $2 packet treats 2 bushels of seed). If there is a local farm supply store, perhaps they can order inoculant for you.
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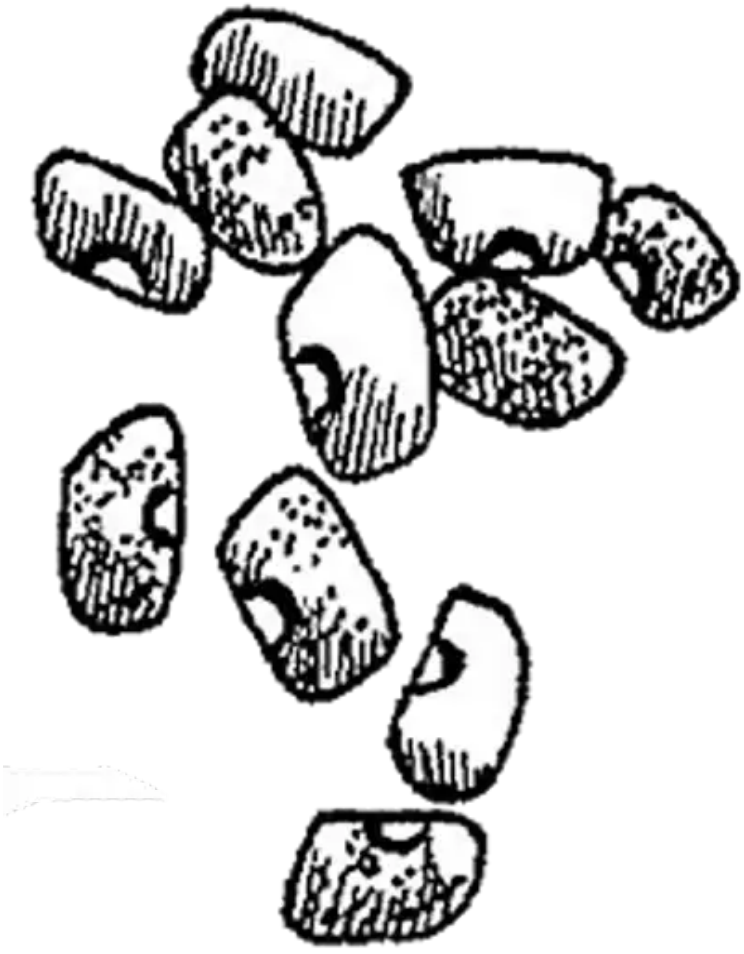
TEPARY BEANS RESIST DROUGHT. (We relied on the books Tropical Legumes: Resources for the Future by NAS, 1979, and Food Legumes by Daisy E. Kay, 1979, in preparing this note.) A frequent question ECHO receives from people working in the semi-arid tropics is, "It is so dry here! What plants can we grow with so little rain?" The tepary bean, *Phaseolus acutifolius,* is a promising crop for semi-arid to arid regions with infrequent but heavy rains and extreme heat.

This native plant of the Sonoran desert in western North America has been an important cultivated food of native Americans for over 5,000 years. When planted toward the end of the rainy season, tepary beans may receive sufficient moisture in a few heavy rains early in their growth to mature and produce quickly, even when conditions at the end of their life cycle are extremely hot and dry. Sometimes, when planted in recently water- logged soils of certain types, production is possible without any additional rain. Richard Pratt at Purdue University had results of yield trials where he compared the effect of drought on teparies and on common beans. As he cut back on water, the yield of common beans decreased steadily whereas the yield of tepary beans actually increased up to a point before they also eventually dropped off. Tepary beans have good potential to yield when very little other food is available.

The countless landraces and local varieties vary widely in color, seed size, and growth habit, but most yield their high-protein crop just 60-90 days after planting. The leaves and young pods are a leguminous forage nutritionally comparable to alfalfa.



(/resources/ce211f7c-940e-4505-83af-10c301d8f8e2)Dried pods may also be fed to animals. Plants are bushy to semi-vining on dry land, with more extensive vining and foliage growth when water is plentiful. The seeds and trifoliate leaves are a bit smaller than in the common bean. Because they are extremely resistant to common bacterial blight, which affects other beans in the tropics, they are used in breeding programs to impart this resistance to the (American) common bean *Phaseolus vulgaris*.

Tepary beans can thrive in areas with as little as 500-600mm (20-24 in) rain per year, and seed production drops with over 1000mm/year (40 in). Seeds are generally planted 10-20 cm (4-8 in) deep to utilize the lower water reserves. Plants often receive 3 or 4 irrigations in the early stages of growth. (Continued irrigation can actually lead to increased vegetative growth and lower seed yield.) Teparies prefer well-drained soils and are fairly tolerant of alkaline or saline soils. They may mature more quickly at mid elevations than coastal regions.

We consider them one of the more promising plants for arid regions. For example, Peter Welle got quick and heavy yields in Haiti in spite of hot, dry weather and calcareous soils. Robert Hargrave from Kenya wrote, "I wanted to report on the tepary beans I picked up when I visited ECHO in 1989. They have proved very promising. During the last rainy season (Nov. 1990 to January 1991) I recorded yields up to 1500 kg/ha on the yellow tepary beans. Admittedly we had higher than average rainfall (over 200 mm, 8 inches), but common field beans would not have produced. Some of my Kenyan friends have also grown and eaten the (brown) tepary beans, and reported favorably on them. I also conducted some inoculant trials with Rhizobium donated by a professor from Trier University in Germany who is conducting studies in this area. It appears that, at least here,there is no need for special inoculant." Dr. Leon at CATIE says that tepary beans can be found in the market on the Pacific coast of Mexico. He has read that they were introduced as a cover crop in the Sahel of Africa, and that people on their own initiative began eating the bean. (We would appreciate more information on this from our African readers.) Dr. Hidalgo at CIAT believes the relatively low yield and a flavor that is inferior to common beans are the main problems with commercialization. But he added that, "As a crop for subsistence farming, its potential is excellent. It doesn't stop growing even when it flowers. So if a stress occurs after the first flowers, it has a high capacity to recuperate."

Despite tepary bean's apparent potential to produce food quickly in semi-arid regions, not much attention has been given to research and improvement of this species by the scientific community. Some obstacles to introduction into new areas include disease problems (in climates where it is not adapted), sensitivity to some salty soils of semi-arid zones, poor productivity in humid regions, tendency toward short-day flowering, frost damage (nighttime temperatures must be above 8Ã¸C/46Ã¸F), unusually small and flat appearance of the bean, a sweet taste different from the common bean, and long cooking time after long periods of storage. (According to Linda MacElwee of Native Seeds/SEARCH in Arizona, they can take up to 4 hours of boiling, even after soaking, if they have been stored for some time. Even fresh teparies can take longer to cook than many common beans.) Teparies may also cause flatulence and therefore are not recommended as food for babies under one year old.

Agronomists at the United States Department of Agriculture in Mayag□ez, Puerto Rico, chose 11 cultivated lines from 70 accessions of tepary after evaluating and selecting under varying environmental conditions. They studied yield, seed size, protein and anti-nutritive factors, and resistance of each line to six diseases.

They found that tepary beans performed best and yielded more than the common bean under higher temperatures in dry regions. (Linda MacElwee says they will produce at 46Ã¸C/115Ã¸F.) The seed protein concentration for the tested varieties ranged from 17.8 to 26.8%, and anti-nutrients that interfere with protein

digestibility were on average less than in the common bean. All lines were resistant to common bacterial blight and susceptible to the bean common mosaic virus, but the lines had varying resistance or tolerance to rust, ashy stem blight, bean golden mosaic virus, and Fusarium wilt.

The seeds supplied to ECHO are photoperiod-insensitive, virus-free, and selected for high yield and disease resistance; in addition, they may be more tolerant of excess rain than other tepary varieties.

We planted the tepary beans in our own semi-arid greenhouse as a trial. They germinated immediately and grew impressively well with none of the disease problems usually evident on tepary beans at ECHO [note: we do not send out the tepary seed grown at ECHO because of the risk of transmitting diseases common here]. In two months, most of the varieties already have pods and continue to flower. There is quite a bit of variation in foliage produced, flowering time, and leaf size. We asked Dr. Phillip Miklas, who sent us the disease-resistant varieties, the following questions on the potential of tepary beans:

Q. In what climates have you found tepary beans to outperform other beans?
A. Tepary beans are outstanding for hot climates, in some cases yielding over three times as much as dry beans when high temperatures cause common bean flowers to abort. They are well-suited to areas which suffer periodic drought. For example, in places which often, but not always, receive enough rain for common beans, you might plant a few plots of tepary beans as an insurance crop. However, in extremely rainy periods, tepary beans will produce a lot of vegetation, but very little or no seed.

Q. The seeds of the disease-resistant beans you supplied are smaller than the seeds we receive from Arizona. Can a grower select for larger seed and, if so, will that affect protein levels?
A. These are true-breeding lines of tepary beans; the plants produced should be genetically similar. It is not likely that you will find wide variation in seed size. Any selection of that nature, though, would not significantly affect other characteristics of the bean.

Q. Are the diseases observed in the study usually a major problem in arid to semi-arid zones, or are they primarily present in humid areas? Is there an advantage for people in extremely arid zones in using the selected disease-resistant varieties over other (larger-seeded) ones?
A. The diseases are present in many tropical climates. For example, common bacterial blight occurs mainly in hot, humid areas, and ashy stem blight occurs in hot, dry areas. One thing to remember is that the strains of each pathogen vary in each region; in other words, we were only able to select for resistance to the strains in our area, but different strains may be present in a new area.

Q. Do you have any comments concerning unique cultural requirements?
A. Fertilization should not be necessary. If you fertilize before the plants have emerged from the soil, nitrogen-fixing nodules may not form. So delay any fertilization until after the seeds have sprouted. [Tepary beans can nodulate with the broad cowpea/lima bean/Canavalia/mung bean group of rhizobia. Under very hot or dry conditions, the nitrogen-fixing bacteria will not persist strongly from one season to the next. In such conditions it may be best to inoculate the seeds.]