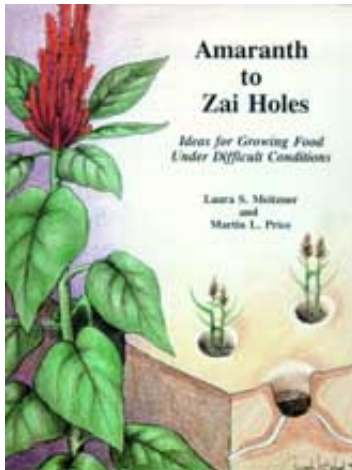




Home-immediately access 800+ free online publications.  
Download CD3WD (680 Megabytes) and distribute it to the 3rd World. CD3WD is a 3rd World Development private-sector initiative, mastered by Software Developer Alex Weir and hosted by GNUveau Networks (From globally distributed organizations, to supercomputers, to a small home server, if it's Linux, we know it.)[ar](#).[cn](#).[de](#).[en](#).[es](#).[fr](#).[id](#).[it](#).[ph](#).[po](#).[ru](#).[sw](#)

---



- 📖 Amaranth to Zai Holes, Ideas for Growing Food under Difficult Conditions (ECHO, 1996, 397 p.)
  - ☐ 2: Vegetables and small fruits in the tropics
    - ➔  (introduction...)
    -  Resources and perspectives - book reviews



## Vegetables and small fruits in the tropics

### **Amaranth to Zai Holes, Ideas for Growing Food under Difficult Conditions (ECHO, 1996, 397 p.)**

#### **2: Vegetables and small fruits in the tropics**

Vegetables and small fruits supply essential vitamins and minerals while adding variety and interest to the diet. Produce can also bring a high price in the market and provide additional household income. Vegetable use varies by region, culture, and social group. One of the first changes people make when they have more income is increasing the diversity in their diets, so you may observe more interest in vegetables and small fruits as families earn more.

Since vegetables and fruits are known to have a significant impact on health and nutrition, many people are interested in

promoting their greater production and use. Many vegetables native to the tropics continue producing for months or years, and these treasures should not be overlooked in favor of temperate vegetables which must be continually replanted. This chapter features resources, perspectives, and information on growing the many vegetables and fruits which have proven themselves under difficult conditions in the tropics.

## **Resources and perspectives - book reviews**

### ECHO'S INVENTORY OF TROPICAL VEGETABLES.

How many kinds of vegetables did God create? You can count the hundreds in this 157-page publication by Dr. Frank Martin, Victor Doku and Ruth Rubert. Plants are considered in alphabetical order by family, with good indices for genus and common names. Within each family the "major" vegetables, if any, are described by a paragraph with standardized format,

while the hundreds of minor vegetables receive only a single line (scientific and common names, type of growth, country of origin, plant part eaten, and whether cultivated or wild). The uses, and any poisonous properties, are noted when known. Thumbing through the book is the best way to find vegetables of a particular country. A very complete bibliography lists the most important sources of further information. Remember that this is an inventory, not a detailed description of everything you might want to know about the plants.

This may be the most complete listing of tropical vegetables ever developed. Because we did not consider the "market" large enough to pay printing costs, we have "published" it as a xeroxed copy in a binder. While most valuable in libraries, many will want a copy on their own desks. At US\$20 (\$15 for private voluntary organizations) plus postage it is a bargain considering the years of work that went into the book, and the difficulty of getting the information elsewhere. Available from

## ECHO.

EDIBLE LEAVES OF THE TROPICS (about 240 pp.) by Franklin W. Martin and Ruth M. Rubert discusses the value of leaves in the diet and describes hundreds of edible leaves. Green leafy vegetables, common weeds, tropical trees, spices and teas, and temperate vegetables in the tropics are included. There is some information on toxic leaves and the culture of green-leaved vegetables. This book has been out of print since the early 1980s, but is in the process of being reprinted by ECHO. It will probably be available in late 1996. Write for details.

GROWING VEGETABLES IN FIJI AVAILABLE FROM ECHO. ECHO receives letters every month from individuals who did not grow up in the tropics, but who now find themselves called upon to do vegetable gardening under tropical conditions. Some have not had previous gardening experience in any climate. Now they may even be expected to teach the subject.

Kirk Dahlgren authored this helpful, concise book while working as a Peace Corps director in Fiji. He discusses both tropical vegetables and techniques for growing temperate vegetables for which there may be considerable demand (and potential profit) in the tropics. We found it so useful both in teaching basic gardening techniques and in bridging the gap between temperate experience and tropical realities that we reprinted it. Growing Vegetables in Fiji costs US\$5 plus postage (\$2.25 N. Am.; \$3.50 S. Am.; \$5 elsewhere).

We find that people moving to the tropics make two opposite mistakes. One is to assume that in the tropics they will easily be able to grow the kind of vegetables they knew from temperate climates. The other is to assume too quickly that it cannot be done. While many temperate vegetables will not grow in most tropical locations, every so often we find someone succeeding with a vegetable we might have urged them not even to try. Experiments in your garden will cost

little and may yield big rewards!

ECONOMIC PLANTS OF IMPORTANCE IN HAITI (44 pp.) is a very helpful book by Dr. Terry Berke. "When I was teaching at the American University in Les Cayes I often had only the Creole name of a plant. Once I had the scientific name I could usually find information about it in my reference books."

The book is not exactly a bilingual dictionary, but it can be used that way. A large table lists the names of a great many plants and the family to which they belong. Trees, vegetables, wild plants, and fruits are all listed. English, Creole and scientific names are alphabetized together. You then turn to the body of the book where each family is discussed. In that discussion the scientific, English and Creole names of the family members are listed along with a very brief discussion of each plant and its uses. This book was extremely helpful on a trip to Haiti. Often we were given the Creole name and had no

idea what the plant was-until we checked it out in this book.

For easy reference to more common plants, the book includes one page of scientific names of common vegetables, followed by the English and Creole names. Another page does the same for fruit and multi-purpose trees. ECHO is publishing the book in-house as needed. The price is \$3.50 plus postage.

SEVERAL AGRICULTURAL BOOKS IN SPANISH. Dr. Keith Andrews, director of the Panamerican School of Agriculture in Zamorano, Honduras, sent several of their agricultural books for ECHO's library. The books and their prices appear below. Write for ordering information to the bookstore at Zamorano, P.O. Box 93, Tegucigalpa, HONDURAS, Central America. (This well-known school is oriented towards hands-on, practical agriculture. After a guided tour by one of their students, I was envious of the practical experience their graduates receive. As I recall, students work half a day in the area they are



currently studying. If studying animal science, then they may rotate through raising animals, butchering, making cheese, processing milk, etc. If studying horticulture, then caring for vegetables, harvesting fruit, selling in the fresh produce store, etc.)

The books include: Cebolla, ajo y puerro (47 pp., \$8); Cultivo de la soya (61, \$8); Gua prctica para el manejo de malezas (222, \$18), Horticultura manual de prcticas de campo (180, \$10); Manejo integrado de plagas insectiles en la agricultura (623, \$30); Ordenes y familias de insectos de Centroamerica (179, \$10); Principios y prcticas de mejoramiento de plantas (119, \$8); Produccion de cabras y ovejas en el trpico (174, \$15).

Other books, which I have not seen, which might be of interest: Caa de azcar (104 pp., \$5); Gua prctica de cultivo de hortalizas (81, \$12); Manual de laboratorio nutricin animal

(110, \$8); Manual de Laboratorio de introduccion a suelos (81, \$5); Microbiologia (\$15); Prctica de campo muestreo de nematodos (11, \$3); Principios prcticos para la produccion de cultivos (119, \$10).

THE ASIAN VEGETABLE RESEARCH AND DEVELOPMENT CENTER conducts research, crop improvement, and offers seed for research and many publications on tropical vegetables. Write to Office of Publications and Communications, AVRDC, Box 42, Shanhua Tainan 741, Taiwan ROC; phone 8866 583 7801; fax 8866 583 0009; e-mail [opc@netra.avrdc.org.tw](mailto:opc@netra.avrdc.org.tw); <http://www.avrdc.org.tw>.

"I WANT TO TEACH HOME VEGETABLE GARDENING" is one of the most frequent requests ECHO receives from people in the field. Small, biointensive household vegetable gardens can supply the vitamins and minerals often lacking in the diet of rural families. For this reason, most rural development groups

have promoted home gardens at one time or another, and some have met with acceptance and enthusiasm.

Many more of these educational efforts, however, have been discontinued once the development staff have left the community. It is worthwhile to encourage people to grow and eat fresh fruits and vegetables, so promoting home gardens seems a simple and effective step in that direction. But the fact that gardening projects all around the world often fail to achieve permanence should make us especially cautious to launch such a program. Some guidelines are given below to help you evaluate the need for gardening education in your area and to identify some limitations to gardening.

If you are new to an area, your first step should be to observe the current growing practices and diet in the region. It could be that you see people growing vegetables for the market, but they do not eat them at home; in that case, simply growing

more vegetables will not improve the diversity in their diets. Or it could be that you do not recognize gardening activities, but people eat many vegetables—for example, wild greens which they gather or perennial plants that are not obviously cultivated. If people are already gardening, you do not need to teach them, but it might be appropriate to examine more productive techniques or evaluate some new plants which could be added to their system. If they are not gardening, there is probably a whole complex of reasons why they are not, and it would be wise to consider the limiting factors before beginning a promotional program. As always, the goal should be discovering the most appropriate way to meet the needs in the community, rather than introducing any particular system. Keep in mind that a truly appropriate technique may spread by itself. My [LSM] observations from one area highlight a few reasons people may not garden.

In the Andean region of Ecuador, much effort has been poured

into "teaching" various methods of vegetable gardening with little long-term adoption of the practice. Most people do not grow their own produce. The most common reasons farmers give include the following: seed supply is erratic and of varying quality (especially seeds distributed free often had poor germination), necessary vegetables could be easily and economically purchased in the market, lack of a regular water source for irrigation, lack of motivation to grow vegetables, difficulty of protecting the garden from free-ranging animals ("neighbors' chickens" are a serious problem), no market for their products, and dislike of vegetables. Pest problems are not reported as a serious limiting factor, and the Andean climate favors the production of a wide variety of vegetable crops.

The primary limitations to home gardening are related to food habits/values and farming systems. Vegetables have low priority in the Andean diet. For example, traditional Andean foods contain little if any vegetable portion: drinks are grain-

based, and meat (cuy [guinea pig], beef, chicken, etc.) and starches (potato and many other native root/tuber crops) are often served without the complement of vegetables. A few green peas or carrots are tossed into the soup, onion is used to flavor meats and soups, some beets or radishes may top the rice, and hot peppers and tomatoes are used in hot sauce, but vegetables make few other appearances on the Andean table. As in much of Latin America-unlike tropical regions of Africa and Asia-leafy greens are viewed as animal food rather than important in human nutrition. People gather some wild greens to add to soups in times of food scarcity, but these foods have a poor reputation and they are not cultivated or preferred.

Chickens, and to a lesser extent other animals, are a primary reason that people are unable to grow vegetables. Chickens are rarely confined, and their scavenging of insects and scraps around the house makes important contributions at little cost. However, their scratching quickly destroys garden beds and

seedlings, and the necessary fences may be too expensive or difficult for people to construct before they begin a garden. Some people said that for this reason, communal gardens met with greater success than individual gardens-only one tall fence had to be constructed to protect everyone's crops together. People who did have gardens were often ingenious in the construction of their fences-using a variety of materials such as scrap wood, old plastic, shrubs, etc. Another important factor to understand is the key role played by the animals raised around the home, especially cuyes and pigs. Some people fed their garden vegetables to their animals, so it was clear that animal production was more important to the families than eating the vegetables.

I occasionally noticed one house which had extensive vegetable plantings in an otherwise gardenless community. When asked how they had such a nice garden, the families' most common responses related to health or economic

benefits. People who maintained gardens on their own knew about the nutritional value of the vegetables, often explaining some specific improvement in the health of their children, such as their teeth or energy level. Others noted the extra income from selling their vegetables. People who found a market and made money from their gardens tended to have large, well-tended gardens which produced continuously with irrigation. These benefits made gardening worthwhile, even for people who did not grow vegetables simply because they liked them.

## **Vegetables and small fruits in the tropics**

AMARANTH IS A DROUGHT-RESISTANT, FLAVORFUL GREEN. (Refer to page 75 for more information on amaranth seed.) Amaranths are cultivated worldwide as fast-growing, short-lived annuals. The leaves are high in calcium and iron. With their relatively high oxalic acid content, leaves should be



boiled before eating. Some species can be weedy due to their high seed production, and leaf-eating caterpillars are a major pest. ECHO has many varieties of vegetable amaranths (mostly *Amaranthus tricolor*) which are favored for their leaves, although leaves of grain amaranths may also be eaten. We usually send two or three varieties when we receive a request, but if amaranth already grows in your area and you want to conduct a larger variety trial, specify that in your letter and we will send more.

**ANDEAN BLACKBERRY.** One of my fondest memories from Victor Wynne's farm in Haiti (at 6,000 feet) is the juice made from this Andean berry (*Rubus glaucus*, *mora de castilla*). It thrives on his farm, bearing over a very long season. Victor says that it bears most of the year, although berries do not command a high price.

According to the book *Lost Crops of the Incas*, this blackberry

is native from the southern highlands of Mexico to the northern Andes. It is widely cultivated in gardens in Ecuador and Colombia. "It is said to be superior in flavor and quality to most cultivated blackberries and raspberries. ...They are especially juicy and make excellent jam, which tastes like jam made from black raspberries."

This plant may be suitable for those working with peasant farmers at higher altitudes in the tropics. The plants are normally propagated by tip layers or stem pieces because they yield sooner, but they can also be started from seed. You must have the patience to baby the seed until it germinates. Victor says, "We kept our original seed continuously moist for at least two months before any seed germinated. Trays should be covered with some air-breathing transparent film to prevent drying out." They grow well on many kinds of soil. In well-tended plantings, annual yields are said to reach 20 tons per hectare.

ECHO does not have seed at present; we would like to receive some from our network in the Andean region.

**BRAZILIAN SPINACH IS A GOOD SOURCE OF GREENS.** Cory Thede in the Brazilian Amazon reports: "Brazilian Spinach (*Alternanthera sissoo*, also Samba lettuce, *sissoo* spinach) forms a thick ground cover. It creeps and roots from nodes over a large area. It responds well to fertilizer. A pest (centipede?) eats holes in the leaves at certain times of the year, but this only damages the appearance a bit. Once planted, it can be maintained permanently, as a perennial. Propagate it by cuttings placed in the ground, with some shade (palm fronds for a week or two); it is very hardy, but keep it moist while rooting. It grows fast but is not invasive. Brazilians usually eat it raw in salads with oil/vinegar, tomato, and onion, although the literature recommends cooking it. This, together with lettuce and collards, are the most common greens in the area. In fact, it is better-liked than lettuce.

Branches are sold in the market-pull leaves off the stems and eat the young vine tips. If you work in the humid tropics, ECHO can provide cuttings if you visit us in Florida or ship them to you just before you leave the States. The cuttings would not survive overseas mail.

BUSH OKRA FROM ECHO GREW WELL. HOW DO WE EAT IT? Klaus Prinz wrote from Thailand, "We could not figure out how to eat the small pods. They ripened quite fast, though, so that a lot of seed was collected." Bush okra is a misleading name. It is actually grown for its leaves, which are cooked and eaten. It is called bush okra because its seed pods look a lot like very small okra pods. The scientific name is *Corchorus olitorius*, also called jute mallow and Egyptian spinach. It is a major source of food from the Middle East to Tropical Africa. The fibers are used in twine, cloth and burlap bags. The better vegetable varieties are smaller and more branched than those selected especially for fiber, but all have edible leaves. A

related species, *C. capsularis*, is the better known source of jute. The plants tolerate wide extremes of soil, are easy to grow and are resistant to drought and heat. Leaves may be dried for later use as a tea or cooked vegetable. They require little cooking. The leaves are mucilaginous (slimy), like okra, so may be offensive to some people. Plants reach over 3 feet (1 m) high and are about 20 inches (50 cm) in diameter. [The above information is from Frank Martin's *Edible Leaves of the Tropics*.] Want to give it a try? We have plenty of seed.

**CASSAVA LEAVES.** Cory Thede also mentions: "Brazilians also dry and powder cassava leaves and add them to foods-this is a very handy form of storage, especially for moms who don't want to leave the house to collect leaves during the cooking. Eating leaves is not too common a practice here, so maybe the powder disguises them well enough to be accepted, especially when used to enrich soups."

We asked David Kennedy with Leaf for Life for his perspective on using dried cassava leaves as a food, since cassava contains substances that produce hydrocyanic acid (HCN) when fresh leaves are eaten or pulverized. "HCN is a fairly common toxin in food. Cassava, lima beans, and sprouted sorghum have caused HCN poisonings. Acute HCN poisoning is quite rare. The minimum lethal dose is estimated at 0.5-3.5 mg per kg of body weight. So a child weighing 20 kg would need to consume between 10 and 70 mg of HCN. Ten grams of a low-HCN variety of dried cassava leaf would contain something like 0.08 mg. Chronic toxicity (also quite rare) has been reported mainly where there is a great dependence on cassava and a very low protein intake. Damage to the nervous system and especially the optic nerve can be caused by chronic exposure to HCN. Low consumption of proteins, especially sulfur-bearing amino acids, cigarette smoking, and air pollution all intensify the body's negative reaction to HCN.

"One would be tempted to steer clear of cassava leaves altogether to avoid any toxicity problems, except that the plant has several important attributes as a leaf crop, yielding large quantities of leaf that is high in dry matter, protein, and micronutrients...throughout the year in most locations. ...People are currently eating cassava leaves as a vegetable in much of Africa, and parts of Asia, and Latin America. I think the question is not whether to eat cassava leaves, but rather how to. Encouraging the use of low-HCN varieties is critical to this effort. A grinding technique that ruptures cell walls will dramatically increase the rate and total amount of HCN that disperses into the air. It is important that the leaves be ground when fresh, and quite well pulped, not just shredded. The loss of HCN is very dramatic then during drying." He sent us a Ministry of Agriculture publication from Brazil which showed the following HCN content for one variety (Cigana) of cassava: fresh-737 ppm; flour from a leaf dried whole- 123.89 ppm; flour from a shredded leaf-75.58 ppm; and 33.60 ppm

when dried after thorough pulping. The potential nutritional benefits of using leaves of this common and productive crop is considerable. (For more on this topic, refer to page 265 in the Food Science chapter.)

CARROT EMERGENCE IN CLAY SOIL. (The following is taken from the July 1993 issue of HortIdeas.) Researchers in Brazil "tested various techniques to boost the emergence rate of carrot seedlings in heavy clay soil. Shading the seed bed worked better than mulching with organic materials such as sawdust and straw; adding a layer of sand resulted in poorer emergence than with bare soil." The HortIdeas editors add that they have "had no complaints about our stands of carrots since we began, several years back, covering the rows with boards until a high percentage of the seedlings break through the soil surface."

HIGH-CAROTENE CARROT SEED AVAILABLE. Dr. C.E. Peterson



wrote, "It is generally agreed that vitamin A is the third most serious nutritional deficiency in the world, following total calories and protein. It is estimated that in four Asian countries 250,000 children become totally blind and many more partially blind each year due to vitamin A deficiency. ... Standard varieties of carrots have 80-100 ppm. The USDA hybrid A Plus has over 150 ppm." The Beta III carrot (not a hybrid) is a "market carrot" with a carotene content of 180-320 ppm. To give an idea for how much is needed, he said that one pound of an experimental variety that has 560 ppm would provide enough vitamin A for an adult for a month. "By comparison, the levels in some vegetables are: tomato 0.5 ppm, Chinese cabbage 23 ppm, kale or mustard greens 18 ppm." ECHO has trial packets of the A Plus and Beta III; if they grow well for you, you may order seed in quantity from commercial sources. Seed for the A Plus carrot may be available in bulk from Asgrow Seed Company, 4420A Bankers Circle, Doraville, GA 30360, USA; phone 800/234-1056, and

Park Seed Co., Cokesbury Rd., Greenwood, SC 29647, USA; phone 800/845-3366. Order the Beta III from Asgrow as well. (If you have difficulty locating Beta III seed, contact Mr. E. Hansen in Kalamazoo, MI, USA, at phone 616/384-5545; fax 616/384-5647.)

Dr. P.W. Simon with the USDA at the University of Wisconsin wrote, "Vitamin A is necessary for normal vision and eye health, mucous membrane and skin health and disease resistance. A U.S. nutrition survey indicated that 40% of Spanish Americans, 20% of blacks and 10% of whites suffer from vitamin A deficiency. [It can cause] night blindness, permanent blindness and even death."

In developing countries, 90% of the vitamin A is typically from plants. The body converts carotene from the plants into vitamin A. Excess consumption of vitamin A itself is toxic, but the body regulates the carotene-to- vitamin A conversion so

that toxic amounts of vitamin A are not produced, even when high amounts of carotene are consumed.

Here are some other interesting comments on carrots from Dr. Simon. Carrots tend to be less sweet if the nighttime temperatures are high, if light intensity is low and if there is a lot of organic matter in the soil. Store under refrigeration or delay the harvest. Do not store in a sealed plastic bag, since they need to "breathe" and will spoil. Do not store carrots near apples or pears, as the ethylene gas that these fruits emit will cause the carrots to become bitter. Carotene is relatively stable during processing-between 5- 20% of it is lost when canned.

The Beta III carrot contains three times as much carotene as typical carrots. "To completely fulfill adult vitamin A needs with Beta III, 140 average sized roots (11 kg) would be required per person per year. This would require

approximately one square meter of land." Dr. Simon says, "The major problem with the Beta III is its long thin 'imperator' shape, in contrast to the short broad roots grown everywhere else in the world but in the U.S.A." His present research is looking for the short, broad root shape and even higher carotene content. He is also looking into solving the difficult problem of carrot production in the lowland tropics. This brings us to another important topic: can you grow your own carrot seed?

UBERLANDIA CARROTS WILL SET SEED IN THE TROPICS. In the spring of 1992, William Tabeka wrote from Uganda. He wanted to grow carrots, but seed was not available. We sent information on the difficulties of producing carrot seed in the tropics. Carrots are biennials; they normally spend a winter dormant in the ground, then produce seed the second year. We also enclosed just a few seeds from a packet we had just received from Dr. Warwick Kerr in Brazil. He said that this

carrot, called 'Uberlandia,' would set seed even in the tropics, and would do so in a single season.

Our interest in this carrot increased greatly when Mr. Tabeka sent us this picture of himself standing by what appeared to be carrots in full bloom. I wrote right away inquiring if that is indeed what I saw, and what he thought of the taste. He replied, "I assure you that the carrots really did put on seeds. The taste of the root is good and there is a difference, because that one which put on seeds has a root that is a bit longer than the others (some high carotene carrot seeds we had sent). There is no difference at all in the appearance of the seeds." A recent letter says he is now growing carrots from seeds that he harvested during the last rainy season.

We planted a few plots in the spring to produce seed for our seedbank. By early summer, they blossomed heavily and eventually produced seed. We need to work on timing to see if

we can get seed during the dry season, as the heat and humidity of our rainy summers make it difficult to obtain high quality seed. Nonetheless, we can now offer our network seed with about 70% germination.

We allowed most plants to go to seed, so we have little information on size or taste of the roots (by the time seed was mature, the roots had shriveled up). I sampled two 3-inch carrots, trying them both raw and boiled. I prefer the varieties I am used to, but if they were the only carrots available, I would be glad to have them. In other trials, we found great variation in the plots, from commercial-sized, bright orange carrots to small yellow roots. Someone familiar with plant breeding could do a great service to the small farmer. Presumably a variety with superior qualities could be developed which would also still produce its own seed. ECHO has plenty of seed, and we continue to select better-quality carrots each year. If you try this seed, we will be VERY

interested in your experience with and impressions of this carrot.

Dr. Kerr provided more information about these carrots.

"Carrots do not usually flower in the tropics. Eighty years ago a group of Portuguese growers planted carrots from Portugal and the Madeira Island in the southernmost state of Brazil. Some of these plants flowered and produced seed. Plant breeders from Sao Paulo and Brasilia independently collected seeds and developed varieties called 'Tropics' and 'Brasilia.'

"I used these two in my work at the Federal Universities of Maranhao and, currently, of Uberlandia. For five generations I selected the best carrots using the following criteria: (1) size between 12-18 cm, (2) parallel sides, (3) red xylem, (4) resistance to local diseases, (5) late flowering, (6) no green on the top of the root. I call the resulting cultivar 'Uberlandia.' The vitamin A content (carotene) is between 9,000 and

11,000 I.U.

"It is advisable that people who grow the carrot in other areas carry out their own selection. Here is how to do it. After 90 days dig up all the carrots. Select the best 30 according to the above standards or standards of your own. Re-plant these carrots right away and allow to go to seed. The red xylem can be observed by cutting 3 cm of the inferior tip (narrow end) of the carrot. Discard if the xylem is yellow."

Dr. Kerr has made a great contribution to third world gardeners. In the USA, nearly all work by private industry and much of the work done at universities is for a hybrid so that people will need to purchase seeds each year and money will be available to fund research programs. We need more breeders working on seeds for the poor.

CHAYA IS ONE OF THE MOST PRODUCTIVE LEAFY



VEGETABLES AND AN INCREDIBLY RESISTANT PLANT. Chaya, *Cnidoscolus chayamansa*, is native to the drier parts of Central America and Mexico, where it is grown in dooryards, often as a hedge. Consequently it has been no surprise to find that it is very resistant to drought. Ross Clemenger planted some cuttings in northern Colombia after visiting us. The weather turned so dry that he had to sell a lot of cattle for lack of forage. The chaya, however, flourished. What has been surprising is that chaya is equally resistant to our terribly hot, humid, rainy summers. In fifteen years neither disease nor insects have been a problem. The only things that have harmed our chaya are freezes and standing water. It will come back from the ground after a freeze, but is killed by a few days of standing water. Plants can reach 10 feet (3 m) in height and about 5 feet (1.7 m) in diameter.

The young leaves are used to wrap tamales or are eaten with the thick terminal stems cooked as greens. They have a firmer

texture than most greens I have eaten. If people in your area eat greens, I think they would likely develop a taste for chaya. For example, an American friend who married a Mexican woman has become quite fond of chaya, and says they like to serve it at least twice weekly. Another friend of Chinese descent is enthusiastic when we take her a bag of chaya leaves, even though it is not a plant she had in China.

Chaya is one of the most valuable green leafy vegetables. It was among the "underexploited" food plants popularized by the National Academy of Sciences. Leaves are reportedly high in protein, calcium, iron, carotene and A, C, and B vitamins. One consideration with chaya is that it should not be eaten raw. It contains cyanogenic glycosides, which can lead to cyanide poisoning. These are inactivated and released as a gas by frying or boiling for 5 minutes. (We discard the cooking water, but that is not essential.) Brief stir-frying is not adequate cooking.

If you work in Central America, you may have heard of Chaya brava in your area. The leaf petioles and stems of this variety contain tiny stinging hairs which make it necessary to wear gloves when harvesting the leaves. Some have brushed against the plant with their bare skin and were left with a red rash. Please note that ECHO now has a non-stinging variety (mansa) available for distribution. If stinging chaya grows in your region, it may be difficult to convince people to harvest and eat it. People who ordered chaya from ECHO before 1990 received a variety with a few stinging hairs; if it was successful, you might want to order this one which is from Belize.

Chaya is easily propagated by cuttings. Though it is frequently in bloom, it almost never sets seed-a quality which nearly eliminates its weed potential. Fortunately, because it is so resistant to dry weather, we can get live cuttings to you. We did a simulated tropical mailing. Several packages of chaya

cuttings, prepared in different ways, were left in our hot workshop during the summer to simulate delayed overseas delivery. They were then removed at 1-4 week intervals and planted. We had good results at up to three weeks, and some survived after four weeks. We sent a package to Asia which was received 10 days later. They trimmed the bottoms and placed the cuttings in fresh coconut milk. In half an hour the surviving small leaflets had regained turgidity. Several cuttings survived. (Some of the edible hibiscus cuttings also survived the trip, so perhaps we can begin sending those as well.) We sent some cuttings in a regular envelope to Dr. Warwick Kerr in Brazil. He now distributes cuttings in the local church and reports that his family eats them at least twice a week.

Arkhit Pradhan in India wrote, "Chaya is all over now from your original cuttings. It's in maybe thirty villages in the hills. People have found it will grow when other greens are not

coming through with the rains-strange plant."

If you want to try chaya in your area and think a small airmail package can reach you in three weeks, we will send you a few cuttings. This will cost us a few dollars in postage, so please only order if you will promptly care for the cuttings. Water the soil moderately but do not keep overly wet while cuttings are starting.

Cory Thede in Santarem, Brazil, writes: "Chaya is iguana-proof! Leaves are within their reach, but they don't touch them. Though it is exceptionally productive in some parts of the world, it grew erratically here-I think a dry-season mite stunted its growth. I did not see much use being made of it in this area.

"Propagate chaya by OLD (grey, not green) thin stalks if they are to be transported, as these have less pith and weight. (For

immediate planting, any part will do.) When it arrives, cut off any rotting parts but you probably do not need to make new cuts if it is healing well. Be sure to plant it right side up, so leaf scars look like smiles not frowns. The bud is above the leaf scar. Leaves are flavorful when cooked with ham, onion, salt, and pepper." [Ed: I prefer them with salt and vinegar.]

**EGGPLANT PRUNING.** Warwick Kerr, head of the biology department at the Universidad Federal do Maranhao in Brazil, prunes his eggplants and African eggplants. The second crop (the farmers call it the "second life") is 30% greater than the first in spite of the death of 10-15% of the plants after pruning. Here is how he does it. When each eggplant has produced 20-30 fruits and the plantation looks old, he cuts the plants at a height of 30 cm, then removes the cut branches from the garden as far as possible or burns them. Finally he applies chicken manure, his cheapest fertilizer, irrigates and sprays the stalks with insecticide and fungicide. All plants that

happened to acquire a virus usually die upon pruning, so he collects his seed from the second crop.

**GRAPES IN WARMER CLIMATES.** The following excerpt on grapes is taken from an article by Rick Parkhurst in the California Rare Fruit Growers newsletter (1981 #2). "For a long time it has been known that the 'wound effect' can replace the cold requirement in grapes. This means that the plant is pruned very severely every year. In the tropics more than 90% of the previous season's growth is removed by pruning. This severe cutting back helps the plant to break the rest period. When the fruit is harvested the plant is pruned. In three or four weeks, new growth appears and in three or four months new fruits ripen. The grapes in the tropics give two regular crops each year. Once this principle was realized, grape-growing spread throughout India, Thailand and other tropical countries."

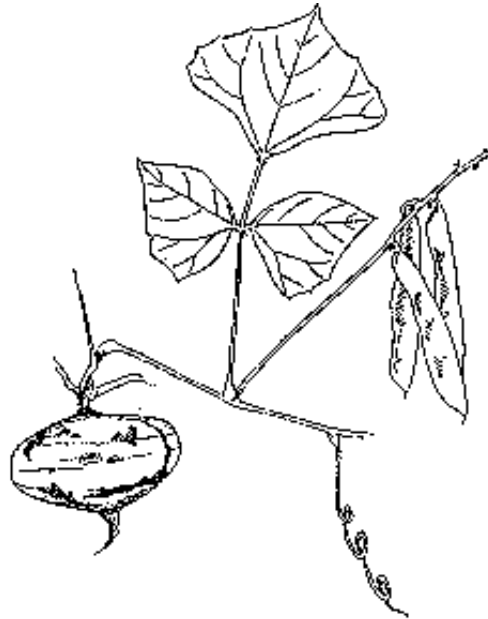
Some additional information comes from a one-page response to a question on grapes that I found in VITA's files called "Grape Vine Management in the Tropics." "Grape vine management in the tropics is a problem: vines tend to be short-lived, produce small crops, and require special care. Grapes like a period with temperatures below 0 C. Attempts in the tropics have not been very successful; plants continuously grow, produce clusters, rebud, remain evergreen, and eventually burn out. However, there are tricks that have been developed for use under dry tropical conditions to simulate a dormancy period. If the vine is forced into two growth cycles, one in the wet season and the other in the dry season, it will produce. By pruning at the beginning of the wet season, a growth cycle is initiated in which a small crop may result. Following this, the vine is pruned again to induce another cycle of growth. It is during the dry season that the main crop results in quality grapes. Irrigation is used in conjunction with pruning to assist the plant during this cycle. (It is a very



common practice to leave too much wood on the plants when pruning and this causes poor quality and premature burn-out of plants). In the dry warm climates of Peru, India and places in Brazil, [the dry season has] simulated a dormancy period." James Smith reports that he ate excellent grapes in the mountains of Cameroon. Grapes are now a commercial crop at a winery just a few miles from ECHO, where most years we have no freezing temperatures.

Muscadine grapes are native to Florida and do not require much cold. They grow as single berries rather than in bunches, and they are very resistant to pests and diseases. Most muscadines are eaten fresh. ECHO has fact sheets on muscadine grapes from the University of Florida for those who are interested.

**JICAMA (PACHYRHIZUS EROSUS) TUBERS MIGHT BE AN EXCELLENT CASH CROP FOR YOU TO CONSIDER.**



## Jicama tubers as excellent cash crop

Of the many new food crops that we have tried at ECHO, I consider this the one above all that should be added to most Florida gardens. For many of you, it is already an important food crop, but others have never heard of it. This is a common

trait of the "underexploited" food plants that are in our seed bank. Most of them are familiar to and liked by at least some of our readers. Very few are wild "weeds" that are being promoted for the first time as food. I will list some of the common names to help you decide whether you already know this plant: jicama (Mexico and the United States), yam bean (not the African yam bean), ahupa (S. America), dolique tubereux or pais patate (French), fan-ko (Chinese), sankalu (India), or sinkamas (Philippines).

Jicama is a leguminous vine grown for its edible tuber. The most unique feature of this tuber is that it remains crunchy after cooking. For that reason it can be used in any recipe that calls for water chestnuts. In a local supermarket we can buy water chestnuts for about \$8 per pound. A 5 x 12 ft. raised bed could probably grow 25 pounds of jicama easily. It retails locally at 75 cents per pound. To the North American tastes of my wife Bonnie and me, recipes lose nothing by making the

substitution. We felt like rich folks during the jcama season, adding jicama extravagantly to water chestnut recipes. It was even the hit of a fondue dinner that we served. Slices of the tuber are eaten raw in salads or with chili pepper and lemon juice, or another dip.

Tuberous root development is initiated by short days. We have planted seed at several times of the year here at ECHO in SW Florida. Regardless of planting date, tubers were not formed until days became very short, around December. For this reason, it is unlikely that jicama can be grown commercially in the USA except in southern Florida and perhaps southern Texas. For maximum size the tubers were usually harvested in January and February. Vines planted in early spring were so vigorous by the time short days gave the signal to produce tubers that very large, distorted tubers burst from the ground. Tubers from seeds planted in May and June had the best combination of large size and good appearance. Seeds planted

in August gave apple size tubers, though the taste and crispness were superior.

The following paragraph is excerpted from the National Academy of Sciences book *Tropical Legumes: Resources for the Future*. Jicama is among the most vigorous-growing legumes. It has coarse, hairy, climbing vines that can reach 5 m long. Although they grow well in locations ranging from subtropical to tropical and dry to wet, for good yields they require a hot climate with moderate rainfall. They tolerate some drought but are sensitive to frost. When plants are propagated from seed, 5-9 warm months are needed to produce larger tubers, but propagating from small tubers greatly reduces the growing time (to as little as 3 months in Mexico). Flowers are sometimes plucked by hand, doubling the yield. [I found no difference in yield in a simple trial in which I picked flowers from half of a small plot. Tubers appear to form only as days become shorter.] Yields average 40-50 t/ha in

Mexico's Bajio region. Experimental plots have yielded 80 or 90 t/ha. The tubers contain 3-5 times the protein of such root crops as cassava, potato, sweet potato and taro. However, the proportion of solids in fresh jicama is only about half that of other tubers because of the high moisture content.

All of the above-ground parts of the plant contain the insecticide rotenone. I would not recommend eating the pods, although immature pods are reportedly eaten at a certain stage in the Philippines. Much of the above-ground portion of the plant can be used as an insecticide, although there are plants better suited to this preparation (such as Tephrosia). One report from scientists in Senegal suggests crushing 2 kg of mature seed into a fine powder and mixing with 400 liters of water. After one day, finely strain the mixture to remove all the seed matter, then apply to plants to protect from a variety of insect pests.

We would like to hear from you if you have experience with jcama in any of three areas. (1) Can the foliage be fed to rabbits, cattle, goats or other animals? (2) Do people use it as an insecticide and, if so, how do they prepare and apply it? (3) If there are special varieties that you think might be of interest to us and others and you can send us some seed to get started, let us know and we will send you a plant import permit. If you would like to try growing jcama and seed is not available in your country, write us for a small packet of free seed.

## ETHIOPIAN KALE GIVES SEED IN THE TROPICS.

Kale is the favorite green in my family, both for its taste, texture and nutrition. A drawback is that it does not set seed in the tropics. Dr. Warwick Kerr in Brazil sent us seed of the "Ethiopian kale" (*Brassica carinata*) which does produce seed. According to Cornucopia, "tender leaves and young stems, up

to 12 inches high, can be eaten raw in salads. Older leaves and stems are cooked and served like collards or mustard. The inflorescence may be used as a broccoli-like vegetable. Seeds are the source of an edible oil." This kale has grown exceptionally at ECHO for years, and we have received many other positive reports on this hardy, productive plant from around the world. It grew so well in missionary Mark Vogan's gardens in Ecuador that he incorporated it into his rabbit feeding system and allows it to grow as a "weed" wherever it sprouts for this purpose.

KATUK (*Sauropus androgynus*) is one of the staple vegetables in Borneo, where it is sometimes grown as an edible hedge. It is one of our favorite summertime greens at ECHO. All greens, whether cooked or raw, are important nutritionally and can be tasty in various dishes. However, few are known especially for their unique taste. Katuk is delicious; after chewing a raw leaf or stem tip a few times you can notice a pea-like or nutty



flavor. The leaves can be quickly stripped from the stem by pulling it between your fingers. Tender tips, leaves, flowers, and small fruits are eaten.

There is another use for katuk in Borneo. By using plenty of fertilizer and irrigation and a bit of shade, they are able to make the tips grow very quickly. The top 5 inches (13 cm) are harvested (there will be only few leaves) and sold to the finest restaurants. I ordered them at the Hilton Hotel in Borneo then watched as they were cooked. The bottom inch was discarded to ensure only tender tips would be prepared and the remaining 4 inches were cut in two. These were then stir fried for perhaps 60 seconds. They can be eaten raw as well.

Malaysian Borneo hopes to export these to Japan as "tropical asparagus." (Of course, it is not really asparagus). A delegate at our Agricultural Missions Conference reported that katuk tips are now being grown and marketed in Hawaii.

Katuk is native to the lowland rain forest understory and prefers a hot, humid climate. It will grow in shade or full sun, and it tolerates occasional flooding and acidic soils. Under ideal conditions, it can grow up to 1.5 m per month. However, stem diameter does not grow apace with length and it soon gets so tall that it falls over, earning its description in *Edible Leaves of the Tropics* as "an awkward plant." In cultivation, it must be regularly trimmed for optimal production of new shoots. Be sure to keep it pruned to between 3-6 feet (1-2 m) high.

Plant about 2-3 feet apart in full sun or partial shade. Because they use shade cloth in Borneo for producing tender tips, I grow it under the eaves on the north end of my house. An additional benefit here is that plenty of water will fall on the plants from the roof even after a light rain and it will get only filtered light. Some people recommend katuk for alley cropping systems with nitrogen-fixing trees. We have had no disease or insect problems at ECHO, although slugs are

reportedly a problem among new cuttings or seedlings in some areas. Katuk will produce abundantly throughout the warm months. During the coldest 2-3 months of winter at ECHO, plants may appear a bit sickly, stop growing, and be less tasty until new growth resumes with warm weather.

Katuk is easily propagated by moderately woody cuttings (20-30 cm long, with at least two nodes), though they can be slow to establish. If you visit ECHO on your way to the field, you can pick up some cuttings. During short days, there will be a lot of small blossoms underneath the stem, which can be stripped right along with the leaves and cooked. Our katuk, vegetatively propagated for some time, flowered but did not produce seed until we acquired plants from a different source (when they produced seed immediately); it is possible that separate plants are required for seed production or some varieties are selected for or against seed production. ECHO seedbank intern Jim Richard collected seed in December and

allowed it to air dry until it was planted in January. It germinated in about 3 months. Since 1996 was the first year we successfully grew katuk from seed, we cannot guarantee that we will be able to distribute it from our seedbank, but if you are willing to wait you can request seed from ECHO and we will put your name on a waiting list until seeds are ready in January.

According to Cory Thede in Brazil, "Katuk and false roselle (*Hibiscus acetosella*) are easy to start from cuttings of any part of the plant, old or new growth (even in the dry season). Strip off most leaves and put the cutting directly into the ground under partial shade. They are survivors and palatable to most people. The false roselle was especially popular because of the red-purple color and sour, tangy flavor. Katuk is a light producer of greens compared to others I grew." [ECHO also has seed of false roselle.]

KIWIFRUIT (ACTINIDIA DELICIOSA) IN THE TROPICS. I have always discouraged people who wrote from the tropics asking where they could obtain plants of this New Zealand vining fruit. It is definitely not a tropical fruit. For example, the newsletter of the Rare Fruit Council International in Florida in 1987 says that kiwi has been tried all over Florida and has never been successful. (The plants grow well, but do not fruit.) So I assumed that it would be even more difficult in the tropics.

A few years ago I toured the farm of my friend Victor Wynne, at just over 2000 meters in Haiti. To my surprise there were vigorous kiwifruit vines and, hanging under them, were several kiwifruit. That does not mean you should all rush off your orders for kiwi plants. First of all, he planted them in 1983 (variety 'Abbott') and later almost tore them out when they never bore. In 1988, he got a few fruit. Though there were several more fruit after the sixth year, it was not at all

clear if there was any commercial potential. That will all depend upon how heavily and reliably they bear.

There is a fantastic annual networking newsletter to promote cooperation and communication among kiwifruit enthusiasts, called the Kiwifruit Enthusiasts Journal. Each issue is like a large magazine, the 1993 issue (#6) having 193 pages. It is a grassroots newsletter, with over 100 people from 12 countries contributing to one issue we saw. Advertisements provide sources for the plants. They do not take subscriptions because its publication frequency depends on who volunteers to help. For the next issue or a back issue send US\$14.95 plus shipping (\$2.25 in USA; \$3.75 overseas surface; \$11.25 airmail) to Friends of the Trees, P.O. Box 4469, Bellingham, WA 98227, USA; tel/fax 360/738-4972; e-mail [trees@pacificrim.net](mailto:trees@pacificrim.net); <http://www.pacificrim.net/~trees>.

Much of the work seems to be toward extending the range in

which kiwifruit can be grown, especially looking for cold-hardiness. To help you evaluate the chances in your area, here are the countries where commercial plantings exist, according to the Enthusiasts newsletter: New Zealand (half of all production), California in the USA, France, Italy, Japan, Israel, Chile, Greece, Yugoslavia, Hungary, Korea, Australia, Spain, and British Columbia in Canada. The newsletter says the coming rage will be smooth-skinned kiwifruit and colored kiwifruit (red, yellow and purple skinned).

Michael Pilarski, editor of the kiwifruit journal, sent us this summary on varieties: "Kiwifruit can be grown in the tropics and subtropics in high elevation areas which receive winter cold periods. The 'Hayward' variety most often seen in the marketplace is one of the poorest choices. The best varieties for low chill areas identified to date by the KEJ network are 'Elmwood' (large-fruited, early bearing); 'Vincent'; 'Dexter' (from Australia); and 'Koryoku' (from Japan). Even more likely

of success are the species: *Actinidia chinensis* (large-fruited, smooth-skinned and sweeter than *A. deliciosa*) and *A. melanandra* (small-fruited, red, sweet fruit)." He is probably the best contact on the subject (see above for Friends of the Trees address).

Kiwifruit is no longer the "get rich quick" crop it once was; it is "over-planted" and prices are dropping on the international market. Some recent plantings made with the help of high-interest loans are going bankrupt. If your country does not produce kiwifruit and your region has just the right microclimate so that you have any chance of producing, kiwifruit might be a long shot for a high-value home market. It is not for most of our network and I would not even think of participating in the export market from a country marginally suited to the crop. If you do try kiwifruit, be sure to let us and Michael Pilarski know the results.



Dr. Campbell gave the following comments in our video tape series on tropical fruits. Kiwifruit is a fruit of warm temperate climates, not of the cooler subtropics. It needs substantial cooling hours (around 45 F/7 C or cooler). Temperatures in the 50s ( F) may have the same effect, but in many more hours. To make matters worse, periods of hot weather during the "cool season" can counteract some of the effect of cool days. When the bearing season arrives, it is important that nighttime temperatures not be too high. (That is presumably why kiwifruit are not a commercial crop in the southeastern part of the United States.) In subtropical mountains suitable conditions might be found, but he speculated that the frequent cloud cover might reduce performance.

Here are some other interesting tidbits from the Enthusiast. Kiwifruit is especially nutritious because the seeds are eaten. (It is technically a "berry.") A five-ounce kiwifruit has more potassium (450 mg) than a six-inch banana (370 mg). It has

almost twice the vitamin C of a medium orange. Avocado is one of the few fruits with a lot of vitamin E; kiwifruit has twice that amount. The skin does not need to be removed (and contains many of the fruit's nutrients). Just scrub off the fuzz with a vegetable brush. In cooked foods, the fuzz virtually disappears and the skin adds a tang and chewable substance not unlike citrus peel. "When pureeing kiwifruit it is important not to over-blend. If the tiny black seeds are crushed, they will turn the drink or soup bitter."

TROPICAL LETTUCE. Dr. Frank Martin gave us our initial start on a tropical lettuce, *Lactuca indica*, also called Indian lettuce. This has grown well in both the hot, wet summer and the colder winter of southern Florida. During the summer it grows to about 8 feet (2.5 m) high. Winter size is about half that. The rather large leaves can be eaten raw or cooked. According to Dr. Martin's book *Edible Leaves of the Tropics*, it is commonly grown in the Orient, mainly cooked as greens, but

it can be eaten raw. We have found it to be quite disease and insect resistant. It is more bitter than the popular lettuces of temperate regions, though after the first bite the bitterness is little noticed. After cooking or when served with vinegar the bitterness is not present. Some local friends have become quite excited about it. Bonnie and I use it as a lettuce only when the weather is too hot for regular lettuce, but it fills a real void during those hot periods. It is good cooked by itself or mixed with other edible leaves at any time. If you are in a region where lettuce does not grow well, write for a free packet of seed. We will be interested to see how it does in different areas. It might even be a good lettuce for a rain forest.

**LETTUCE (LACTUCA SATIVA) VARIETIES SUITED FOR HOT AREAS.** Montello. Our readers in the warm lowlands probably have a problem growing lettuce. I attended the combined annual meeting of the Caribbean Food Crops Society and the

tropical region of the American Society of Horticultural Sciences in Trinidad. One of the field trips was to visit a commercial lettuce operation. They were growing very nice lettuce for the hotel and other markets, even though the location appeared to be near sea level. The variety was 'Montello.' The plants were under shade cloth in long narrow bags filled with artificial potting mix and carefully watered. They looked beautiful, though I did not get to open up a head. They may not be as tightly packed as iceberg lettuce grown in a temperate region, but the quality is apparently quite acceptable. It has large, dark green heads and reportedly ships well. Timing is crucial because the plants do go on to bolt. We saw one bolted planting that had apparently matured when the market could not take them all. Rhine Fecho, who has started an Episcopalian agricultural school in Haiti, told me that he was growing this same variety in full sun, in soil, in August near sea level.

ECHO has purchased 'Montello' lettuce seed and will send a small trial packet to our overseas readers who wish to try it. You should be able to increase your own seed (or purchase in bulk from Twilley Seeds, P.O. Box 65, Trevose, PA 19053-0065, USA). Bend seed heads into bags and shake off the mature seed. We have found that the fluff can be removed from the seed by placing it in a jar and stirring vigorously with a fork. Alternatively, harvest plants when 30-50% of the seeds show white fluff and dry for a few days. Seed can be stored in airtight containers in the tropics for 6 months if dried to 8-10% moisture. (One way to get seeds this dry is to leave them in a closed container with excess desiccant and keep replacing the desiccant with fresh until it remains dry. This is seen easily if you have a small amount of desiccant that turns color when wet. Lacking the indicator, you will have to use your judgment.) In a cool dry place (refrigerator) it can be stored 6 years.

Roy Danforth wrote from Zaire that the Montello lettuce "is superb. It heads very nicely and is not bitter. It is similar to the iceberg variety. It heads after it has produced a good salad bowl's worth of leaves and produces a lot of good viable seed, which I've started spreading around everywhere." Roy works 3 degrees north of the equator. In our own summer gardens we find it difficult to grow. We have free trial seed packets for third world workers (U.S. readers should request our seed sales list).

Queensland. Pat and Connie Lahr gave us a packet of seed for this lettuce after a visit to Australia. Pat believes it is grown primarily by an association of organic market gardeners. As far as he knows seed is not sold commercially. It is a big leaf lettuce that appears to be exceptionally resistant to bolting. Leaves are large, somewhat resembling a cos-type lettuce, with an attractive yellowish hue. In Australia they say it produces 8 weeks in summer, up to 14 weeks in winter and

that it is best to use lower leaves.

My main interest is their apparent resistance to heat. We have not done carefully controlled experiments, but 'Queensland' appears to outlast most of our lettuce varieties when the warm season arrives. Each time we grow it I wonder, "Is this ever going to bolt so we can save seed?" (A key to preventing bolting is to make sure the plants are never water stressed. It might well be that they would bolt quickly if we did not have irrigation.) ECHO produces a small quantity of seed for our network. Be sure to save your own seed if it does well.

Several people wrote concerning their results with 'Queensland' lettuce. Ken Turner in the Philippines says "it was the best of 10 leaf lettuces tested, for ease of growing, durability and taste. I'm impressed. If leaf lettuce could just become an alternative here to head lettuce, this could be a winner. Head lettuce sells for \$3 per kg in some months."

Victor Sanders wrote, "'Queensland' lettuce does very well here in Haiti (in the mountains of La Gonave). We are getting all the lettuce we need during the dry season. I am growing it [with your rooftop garden methods] but on top of the ground. This method is working well in that it greatly reduces water loss in the soil below."

Maioba is Brazilian in origin, noted as high in vitamin A and resistant to acidic soils. Available from ECHO.

Anuenue is bred for resistance to tip-burning and heading under warm growing conditions. You may purchase it in bulk from the University of Hawaii (Seed Program, Department of Horticulture, 3190 Maile Way, Room 112, Honolulu, HI 96822, USA; they only ship to US addresses; phone 808/956-7890).

LUFFA GOURD (*Luffa acutangula*-angled and *L. cylindrica*-smooth; preferred for sponges) is well known in temperate



countries for producing "sponges." The plant prefers hot growing seasons and is a productive vegetable in the tropics. Young fruits can be eaten raw or cooked. In Asia, the young leaves, flowers, flower buds, and roasted seeds are all eaten. Immature fruits may be harvested about 2 months after planting, while the mature fruits used for "sponges" require 4-5 months. Submerge mature fruits in water for a week so the fruit disintegrates, then wash and dry the fibers, bleaching with hydrogen peroxide before drying if desired.

MALABAR SPINACH (*Basella alba*, *B. rubra*) is a very succulent vine grown throughout the tropics for the young leaves and stems, often used as a potherb. The flavor is mild, and the leaves are somewhat mucilaginous when cooked. They can also be eaten raw. It is tolerant of many soil types. Plant seeds or vine cuttings to establish the plants, and harvest regularly. This is a productive, low-maintenance perennial with few pest problems, although nematode damage is so severe at ECHO

that it only thrives in soils high in organic matter.

MORINGA REPORT. Cory Thede in Santarem, Brazil, wrote: "We have a marked dry season of 5 months or so. Moringa (*M. oleifera*) did well in the city but didn't grow well in infertile rural soils. Maybe calcium from the cement, and possibly other nutrients that accumulate in the city, made the difference. Iguanas are a serious garden pest in the area, and they like it...they try to climb even a young plant to eat the leaves, but it is fragile and they knock it over. The young leaves are easy to prepare for cooking; avoid the tough stems of the older leaves. A moringa hedgerow is a convenient way to assure a steady supply of young leaves." This is a very important, drought-resistant vegetable tree. Be sure to see the chapter on Multipurpose Trees for much more information on moringa.

NEW ZEALAND SPINACH GROWING HINTS from James Gordley in Panama. "I am having great results with New

Zealand spinach, *Tetragonia tetragonioides*. [Ed: This is a popular spinach substitute in hot parts of the USA. Because most seed catalogs carry the seed, ECHO does not. One seed source is Burpee, Warminster, PA 18974, USA.] By tying it up on chicken wire it takes very little space and the leaves are kept off of the ground. Before using the wire I had trouble with mold growing on the underside of the leaves. Not anymore. I also find it helpful to use a straw mulch around the plants, especially during hard tropical rain storms, to keep the leaves from being splashed with mud. The muddy leaves also become diseased. With the mulch and wire, neither are problems. I harvest the leaves and allow the stalk to remain on the wire. Within days new leaves have grown out and one cannot see where the leaves were removed. We clean the leaves then soak for three minutes in a solution of 1 tablespoon of 3% hydrogen peroxide in 1 quart of water. There is no aftertaste from the peroxide."

"OKINAWA 'PURPLE' SPINACH (*Gynura crepioides*) looks similar to a local Brazilian weed-both are purple under the leaves, but the weed has an upright growth habit and is an annual. The cultivated type, which may be a selected weed, is perennial, branching, and tends to fall over, making a bush. It grows very well and is pest-free. It has a tasty, pine-like flavor and did well in poor soils. Mix it with other vegetables; the unique flavor may be too strong on its own." Cory Thede reports this success from Santarem, Brazil. Cuttings available at ECHO.

AFRICAN OKRA VARIETY IN ECHO'S SEEDBANK continues to produce when days are short, unlike many okras. The pods are edible to a fairly large size. This variety was much sought after by Haitians when they saw it in full leaf and producing in the Central Plateau in August, when their other okras had died. If okra is already grown in your area, this one may be well worth a trial for comparison.

ONIONS IN THE TROPICS AND SUBTROPICS. A case could be made that onions are one of two universal vegetables that are cherished in almost every culture, tomatoes being the other. Both are difficult to grow in many tropical and subtropical climates. Where a vegetable is both popular and difficult to grow, it brings a good price. If a way can be found to grow that crop, both local farmers and consumers will benefit. While attending a horticulture conference in Honduras, Scott Sherman and I had an opportunity to visit with Dr. Lesley Currah. She travels the third world working with onion researchers. The interview follows. Be sure to note the offer of seed for a variety trial of these onions in the chapter on Germplasm.

Q. Tell us more about the Natural Resources Institute where you work.

A. The NRI is an agency of the British government, the Overseas Development Administration. Their purpose is to use

science and technology to help people in third world countries develop using their own natural resources. Help is offered to any country eligible to receive British aid.

Q. What is your assignment?

A. I work in the fruit, vegetable and root section. My current assignment is an evaluation of onion production and storage in low latitudes. A particular interest is to expand onion production in very wet climates and on islands at sea level. Our approach is fourfold. (1) We are promoting a network of contacts on onions in the tropics through a newsletter called "Onion Newsletter for the Tropics." (2) We evaluate onion varieties through trials done by collaborators around the world. (3) We provide training in how to do a trial and interpret the results. (4) We maintain a gene bank of interesting onion accessions.

Q. Often a development worker from a temperate climate will

plant onion seed from home only to find that it only makes "little green onions," no bulbs. Explain what is happening.

A. Onions are very sensitive to day length. The kind of onion that is grown in the higher latitudes requires long day length to form bulbs. When onions are grown during short days it is important to plant what are called "short day onions."

Q. Is there a sharp border between long and short day varieties or are there degrees of short-day-ness?

A. There are several intermediate degrees, which would be common in places like north Texas or Spain. A well organized seed catalog will not just say whether onions are "short" or "long" day varieties. They will organize them under day lengths, e.g. 11-13 hour, 12-14 hour etc. Some varieties like Beth Alpha in Israel go to less than 12 hours. These mature around Christmas. However, because the quality of onions

harvested at mid-winter is often inferior, e.g. with more double bulbs, farmers usually want onions to mature as days begin to lengthen but before the rains have started.

Q. What does happen if you plant a long day onion near the equator?

A. As you said, they grow into little green onions. They may thicken a little at the base. They may actually be preferable for producing little green onions because the short day types might begin forming bulbs too soon.

Q. Do onion sets exist for short day onions?

A. Many in the tropics use the set system to get onions going near the end of the rainy season in order to extend the onion harvest forward in time. Probably 30% of the onions in Bangladesh are grown that way. Sets are commercially available in Zimbabwe. However, the quality of onions grown from sets can be inferior, for example with more double bulbs.



Q. How would a farmer make his/her own sets?

A. Just as the hot season is starting, sow seeds at a very close spacing. Do not thin the onions. Harvest at ½ inch (1.25 cm) diameter or else they will bolt. If they are sufficiently crowded and if it is well past the day length where the variety would normally bulb, they will die down naturally. It may take a few seasons of trial and error to get it right. Keep the sets in an airy, warm place, such as just under the rafters.

Q. Under what conditions might a farmer be able to save his/her own onion seed?

A. This is difficult. You need a variety that will easily bolt (send up a flower stalk) the second year. You do not want any variety that bolts the first year because that trait would create havoc in your harvest. Select bulbs from the best onions and store until the next season. Timing then becomes important. If you plant too soon while daily temperatures are increasing they may go into bulbing mode and split rather than flower.

Wait to plant the bulbs until the average daily temperatures have started decreasing. The stalk gets a lot of diseases so, unless it is very dry, you may need to spray a lot.

Q. What do you look for in a variety trial?

A. You would want most varieties in your trial to be acceptable to local people. If onions are eaten raw, you want varieties which are mild; if cooked, pungent onions that store well. The pungency, by the way, depends not only on the variety of onion but also on how much sulfur is in the soil. You would want to look for onions where a high percentage of the harvested bulbs are marketable and where the bulbs store well. Even the shape and color may affect marketability and price.

Q. How should onions be stored?

A. We are writing a bulletin on storing onions in the tropics. The humidity should be about 75% and the temperature 25-

30 C. If the temperatures drop much below 18 C the onions may begin to sprout. For example, in Zimbabwe we found that stored onions began sprouting when evening temperatures dropped to 15 C. This is somewhat dependent upon variety, but only to a limited degree. Light is not a very important factor. Light may cause some fading of red onions on the surface only. Light can also cause some green color to develop in white onions.

Q. Do short day onions store reasonably well?

A. Yes, but there is room for improvement. The Israelis have been working to select grano and granex types that will store for a long time. The factors they select for are ability of the bulb to go into a good dormant period and qualities in the skin that will protect the bulb. Their varieties are being tested all over the tropics.

Q. I notice a lot of short day onions named "grano" or

"granex," followed by a number. What are these?

A. Texas grano onions came from onions in Spain which overwinter well in the field, but have poor storage characteristics in general. The granex series is hybrid, the grano open-pollinated (non-hybrid).

Q. This brings up an important question. If you are working where it is possible to produce your own onion seed, would it be a big mistake to save seed from a hybrid onion?

A. No, if you are prepared to do a little selection, and if the hybrid is much better than the locally available varieties, you might end up ahead. For example, in India the Pusa Ratnar variety came from the red granex hybrid. You might have some problems with male sterility in early generations.

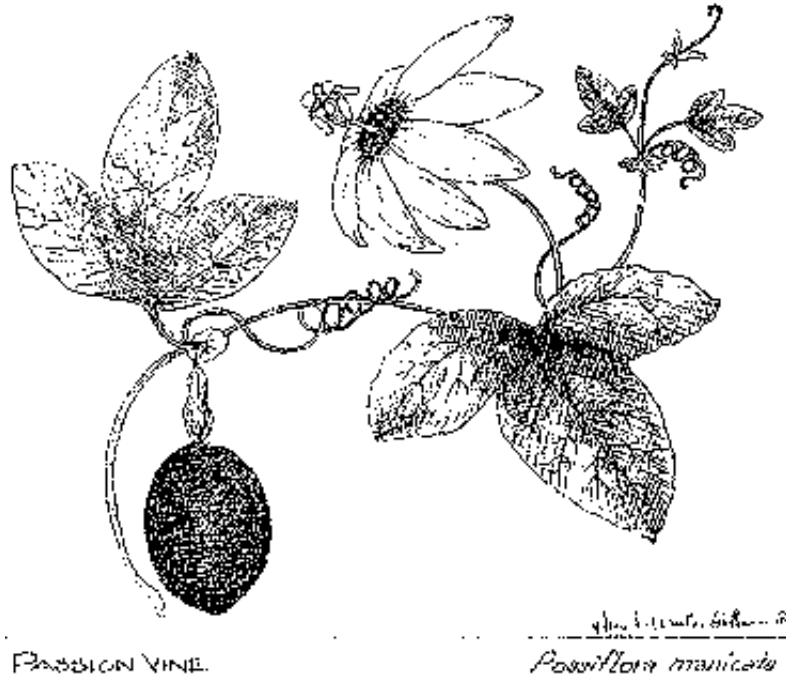
Q. How are onions pollinated?

A. Onion pollen is sticky, so there is not much wind pollination. They are pollinated by insects, such as honeybees. Some seed producers throw dead chickens in the field to attract blow flies. Some crawling insects are also pollinators.

Q. Some of the special seeds that ECHO distributes have come from members of our overseas network. Is there any way in which they might help you?

A. I am interested in any traditionally maintained, locally grown onion. However, the needs of our seed bank require that we obtain about 50 g of any new accession. England is so far north that we are unable to increase the seed ourselves. If someone has an onion that might be of interest, they should first write and tell me as much about it as they can, and why they value the onion. My address is Lesley Currah, Horticulture Research International, Wellesbourne, Warwick, CV35 9EF, UK.

# PASSION FRUITS FOR HIGHER ALTITUDES.



Passion fruits for higher altitude

Two of the passion fruits covered in Lost Crops of the Incas are

the sweet grenadilla, *Passiflora ligularis*, also called sweet passion fruit and the purple passion fruit, *Passiflora edulis*. Victor Wynne in Haiti says, "I particularly recommend the sweet passion fruit to anyone with growing conditions approximating ours, perhaps over 5,000 feet, and a good depth of soil or subsoil to hold moisture during dry spells. The fruit never fails to sell locally to the supermarkets at a good price. It takes about six months for the young vines to get established, and they should be protected from strong sun. We have strung a horizontal wire on 8 foot posts set 1.5 feet into the ground. The fruit is borne on side branches which reach almost to the ground." He would like to get away from posts and wire and is experimenting with trees. The vine "is in no way a killer of trees (i.e. it does not smother them as do some other *Passifloras*). It is more moderate in its growth." Unlike the yellow passion fruit grown in the lowlands, this one "does not fall when ripe, so must be picked. Thus, a support tree should have a structure allowing one to climb up to reach the

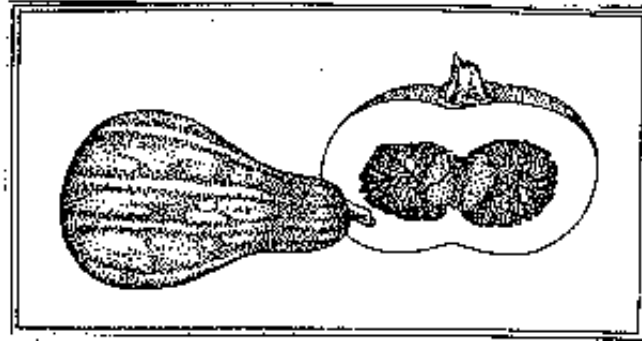
fruit."

According to the Lost Crops book, this fruit has been grown as low as 800 meters and as high as 3,000 meters in Bolivia and Colombia. Because of its strong rind, "it transports well without injury. Consequently Colombia is now exporting this fruit to Europe." It flourishes in Hawaii and is grown somewhat in New Zealand. "This plant sets fruit less abundantly than the common passion fruit, but can produce two crops a year. Because of its resistance to root and collar rot, it is a useful rootstock for other passion fruit species. ...Some people find [the taste] too sweet and flat, which is why lime juice is often added."

ECHO sometimes has small quantities of seeds of these varieties. Please let us know if you have seed to spare. This fruit is already grown in most tropical countries, so you may be able to find seed locally.



SEMINOLE PUMPKIN IS A MULTIPURPOSE, PRODUCTIVE VEGETABLE. I had wanted to get seed for the Seminole pumpkin ever since Dr. Julia Morton sent me a copy of her article: "The Sturdy Seminole Pumpkin Provides Much Food with Little Effort." We finally obtained seed and planted a single hill in an out-of-the-way spot and gave it almost no attention. It vined through weeds in a large area and produced 20-30 pumpkins, which we ate using winter squash recipes. We love the flavor, finding it a great tropical substitute for the popular acorn squash. Each is a convenient size, somewhat bigger than a large grapefruit. ECHO has seed of several varieties. If it produces in your climate, you will be able to save your own seed.



seminole pumpkin multipurpose vegetable

Julia Morton writes, "It will spread over the ground, drape a fence or climb a tree; needs to be fertilized only at planting time; requires no protection from insects. The fruit, variable in form and size, is hard-shelled when mature and keeps at room temperature for months, is excellent baked, steamed, or made into pies. The Indians sliced, sun-dried and stored surplus pumpkins. Very young tender fruits are delicious boiled and mashed; the male flowers are excellent dipped in batter and fried. Thus the vine produces three totally different

vegetables. This is an ideal crop for the home gardener. The portion of the vine which has borne will die back, but vigorous runners, which root at the nodes, will keep on growing, flowering and fruiting, yielding a continuous supply."

The fruits were seen hanging from oak trees by early settlers as they canoed through the Florida's Everglades. The native tribes girdled the bark of oak trees to kill them, then planted the pumpkin at the base (a technique we are not recommending!). ECHO also has several other varieties of pumpkins which you may request if they produce well in your area.

**QUAIL GRASS (CELOSIA ARGENTEA) IS AN EXCELLENT SPINACH SUBSTITUTE FOR HOT WEATHER.**



## Quail grass

Often folks from the States form the opinion that vegetables will not grow under the difficult tropical conditions where they work. It would be more accurate to say that vegetables which they knew in the temperate zone may not thrive there. You will find gardening to be much easier if you grow food plants that God made for climates like yours. Quail grass is a good example. Even in temperate regions spinach only does well in the cooler part of the season and certainly will not grow in the hot tropics. Quail grass, on the other hand, will grow to about 8 feet when spaced about a foot apart and has leaves which taste very much like spinach. (It might be more productive to plant much more closely than that, however.) Roy Danforth tried it in Zaire. He wrote that he was very pleased that it tasted so much like spinach. More important, the local folks are quite interested in it also.

I understand that it is already an important vegetable in parts of Africa and elsewhere. It is not a grass at all, but is in the same genus as the ornamental celosia and cocks comb. Young growing tips or older leaves are cooked for only a few minutes to soften. The water becomes an unappetizing black, but the leaves are an attractive green. The taste is spinach-like with no trace of bitterness. The cooking water should be discarded because it contains oxalic acid.

We sometimes like to cook greens in a steamer. When we cooked quail grass that way the leaves were black and had an unpleasant taste that we had not noticed before. Apparently the black pigment and the oxalic acid that are normally removed in the cooking water were all left in the steamed leaves.

I have found no specific nutritional information, but it is in the same family as amaranth and is claimed to be similar except

lower in protein. The leaves should be high in vitamins A and C, iron and calcium. The calcium would not be available because it is tied up by oxalic acid. The oxalic acid should pose no danger unless leaves were eaten in unusually large quantities.

Like its ornamental relatives, quail grass is attractive in its own right. When the days become shorter in late August it is covered with purple blooms. The inflorescence becomes longer and longer, remaining purple at the tip. The basal end turns brown and contains ripe seeds while the tip continues to bloom (and attract bees and other insects). A row in the garden is attractive with or without blossoms.

I have often wished for a vegetable that grew like a weed without all the tender loving care that is so often needed. Quail grass is such a vegetable. Every place I have grown it, it reseeds itself abundantly. We need do no work to grow it. It

definitely could become a weed problem (although an edible problem). We have had no disease problems and very little insect damage. It is susceptible to nematodes, so a mulch is helpful. It is killed by standing water or freezing temperatures, but does quite well in our cool winter as well as the hot summer. ECHO has plenty of seed. Please share your results with us.

Peace Corps volunteer Jessica Jacklet tested a packet of quail grass at her site in Panama. Few vegetables were grown in that area, as most vegetables performed very poorly. This picture shows Jessica (5'10" tall) standing by the quail grass, which was reportedly untouched by insects. The foliage was rich and dark with lovely purple flowers. Those who started growing quail grass are very proud about its exceptional growth. She introduced the plant as "purple spinach" to the villagers, who are learning ways to incorporate the leaves into their recipes. So far, people have added the leaves to a rice



and lentil dish, and one containing eggs and tomatoes. This very productive plant is hardy and attractive, and it merits trial in more areas.

**RHUBARB GROWN AS AN ANNUAL.** Rhubarb is a common perennial plant in temperate regions, and it thrives vegetatively in cool highland regions in the tropics. In the Andes of Ecuador, it is widely appreciated among farmers, and many seek root divisions so they may continuously harvest their own rhubarb at home. People make sauces, pies, and juices of the tart stems. However, rhubarb is not adapted to the tropics, and the plant will not survive the extended heat and humidity of tropical lowlands. If you are now in the tropics and miss cooking with rhubarb, you will be happy to know it can be grown as an annual from seed. We grew the red-stalked variety 'Victoria' ("the deepest red of all seed-grown types") from the Park Seed Co., Cokesbury Rd., Greenwood, SC 29647, USA. In Florida, we plant the seeds in August,

transplant in October, and harvest rhubarb through the cool winter season. The plant gradually dies off through the summer.

Ralph Kusserow in Tanzania wrote, "You mentioned in EDN about growing rhubarb as an annual. I have been doing that now for several years and it works. We just start taking from it as soon as it is ready. The plants always die eventually from some sort of root rot. I have to watch that I don't overwater it." Most stems of seed- grown rhubarb will be green rather than the intense red selected through vegetative propagation, but tasting a rhubarb pie in the subtropics made us overlook that quickly!

**STRAWBERRIES.** Strawberries would seem to be an "underexploited" cash crop in some countries. For example, Jose Postigo began a project at about 3,000 feet in the Dominican Republic, using U.S. varieties. Within a year he was

selling dozens of boxes of beautiful berries in the capital. Several women also created jobs making jam from excess or older berries in their homes.

Strawberries bred for temperate zones only flower in long days, so varieties used in most of the U.S. would not yield fruit at low latitudes. You must grow day-neutral varieties in the shorter days of the tropics. The following are listed in a publication from California: 'Douglas,' 'Pajaro,' 'Vista,' 'Brighton,' 'Hecker,' and 'Aptos.'

Here at ECHO I have been pleased at the size and quality of berries and plants grown from seed. (Strawberries are normally propagated by runners.) I have not compared them to commercial varieties, but it is a good way to introduce plants to remote locations. Angelino Chipana and Abdon Paredes in Bolivia gave me a picture of a successful plot they began from seed. Though a few others say the plants are

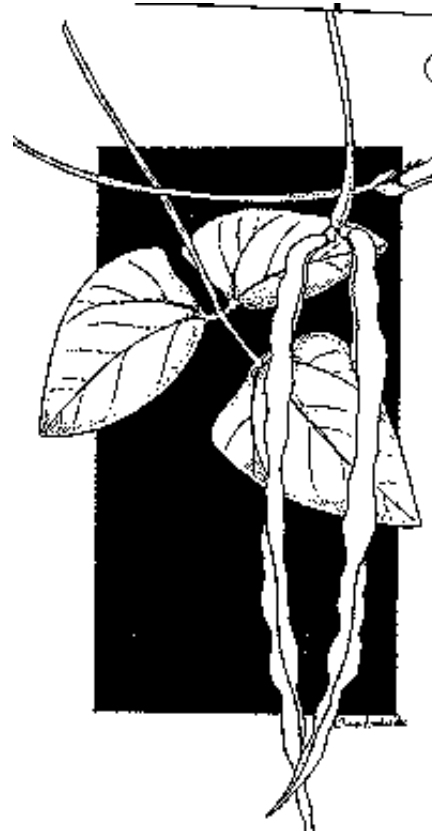
living, we have received no other reports of successful plantings. Some reported the plants were eaten by ants. Many had no germination. This could be related to heat, though ours always germinate even in the hot greenhouse in the summer. If you know of strawberries being grown in the tropics at other than higher altitudes, send us details. We are always interested in "tricks" to grow crops outside of their normal environment.

ECHO does not carry strawberry seed. The "Sweetheart" variety can be ordered from Park Seed Co., Cokesbury Rd., Greenwood, SC 29647, USA (25 seeds for about \$2 plus postage; they bear the same year they are planted). If you can get fruit of the 'Douglas' variety, blend at a low speed in a blender, then separate and dry the tiny seeds. Plant by scattering on top of moist potting mix and patting with your hand to barely embed the seed into the soil. To make sure the top of the soil never dries out, place a glass or plastic sheet

over the pot until they begin to emerge. Be sure NO sunlight hits the pot or it will overheat with the plastic covering. An alternative might be to set the pot in a basin containing an inch or so of water. We have pulled together considerable information on strawberries in the tropics; contact ECHO if you have more questions. If you are in the tropics but not at least 3000 feet (1000 m) elevation or on a very dry but irrigated farm, forget strawberries.

SWISS CHARD. Dale Gunnar in southern Texas writes, "We harvest swiss chard year-round. When we pull up the old stalks in late winter or early spring, we bury sections of the stalk. These quickly root and send up new growth. This is much faster than reseeding." Over the years, ECHO has received many reports from our network that Swiss chard produces well and long. It does well for us only during our mild winter season.

THAILAND LONG BEAN (*VIGNA UNGUICULATA*) PRODUCES  
ABUNDANTLY IN THE RAINY SEASON.



Thailand longbean

Gary Rohwer writes from Nigeria: "The nature of the wet, humid growing season makes beans the best crop to fight against hunger and improve nutrition in this area. In particular, the Thailand Long Bean [a cowpea with an edible 10-inch pod] is a very impressive variety. It resembles a bean which is grown in Nigeria and eaten by the people here, so there is no problem in introducing this variety. The most impressive factor is that this variety grows so quickly. The beans which the people here have been planting only produce once in a growing season, but Thailand Long Bean could be planted three times if not four during the rainy season. I have introduced the bean and people have really been excited about it. If it was planted on a large scale here, they could really see the results." ECHO grows seed for our seedbank during the summer.

**TOMATOES IN THE TROPICS AND SUBTROPICS.** Tomatoes and onions are the most universally known vegetables. They are



so versatile that they are readily accepted in most cultures. One of the most common statements we hear from development workers in the field is, "They grow good tomatoes here, but only small cherry or plum types. I think there would be a lot of market potential for some of the large types that we have in our gardens back home. Could you send me some seed of big tomatoes so I can introduce them here?"

People in the lowland tropics only grow the smaller (cherry and plum or roma) types for good reason: fruit set of large market tomatoes is very poor in many hot, tropical areas. If you have a variety of large tomato that is healthy and flowering, then the reason it is not setting most likely has to do with temperature. Both daytime highs and nighttime lows have a variety of effects on the ability of a tomato to set fruit. Small tomatoes seem to be less adversely affected by these extremes, which is why those types are the ones in local markets. We had hoped to find clear-cut guidelines but could

not, so we will venture our own: If daytime temperatures are not less than 33 C (92 F) and nighttime temperatures less than 22 C (72 F) you may experience difficulties. If daytime temperatures are over 40 C (104 F) or nighttime temperatures over 26 C (79 F) you will almost surely have poor fruit set and possibly damaged fruit.

These may not be bad rules-of-thumb, but as so often happens in real life, the reasons are too complex to be precise. Here are some of the factors so you can understand what is happening, and possibly find a solution.

Effect of nighttime temperatures. These can be either too low or too high. Temperatures at night that do not drop to at least 79 F are clearly damaging to fruit set. Cultivars that were developed for early production in temperate regions had to be able to also set fruit earlier-when temperatures were low. These cultivars can set fruit as low as 4.4 C (40 F). On the

other hand, cultivars developed for warm climates typically will not set fruit if night temperatures fall below 10 C (50 F).

Pollen grains must germinate before the ovule can be fertilized. At 25 C (77 F) germination takes about an hour; at 10 C (50 F), 5 hours; at 5 C, (41 F) 21 hours. Once it germinates, the pollen tube must grow until it reaches the ovule. This growth rate increases with temperature from 10-35 C (50-95 F), but is reduced outside that range. The ovule may deteriorate before it is fertilized.

Effect of high daytime temperatures. The anther must dehisce (burst open) before its pollen grains can be released. This process is inhibited by temperatures that are too high. At temperatures over 35 C (95 F) the surfaces of both the pollen grain and the stigma may dry out, which causes poor fruit set. The pollen germination rate increases with temperatures up to a point, but over 37 C (99 F) germination is greatly inhibited.

A high of 40 C (104 F) seems to be a critical point. Exposure to temperatures greater than this can damage both ovules and pollen production. E.g., if the ovule has been exposed to very high temperatures nine days before flowering, it can deteriorate. Once fertilized, the endosperm of the developing seed can deteriorate at over 40 C (104 F) for between 1-8 days after fertilization.

The difference between daytime highs and nighttime lows (diurnal variation) is also important. In regions and seasons where days are long, tomatoes are not productive unless the difference between day and night temperatures is at least 10 F. We have been told that a very high diurnal variation, as might occur in a desert or high in the mountains, can apparently overcome some of the effects of high temperatures listed above.

Fruits that do set at high temperatures are often so badly

damaged or misshaped that they are not marketable. Also red varieties tend to become more orange at higher temperatures. This is because synthesis of the red pigment, lycopene, is slowed at high temperature but the orange pigment,  $\beta$ -carotene, continues to accumulate normally. Presumably tomatoes grown under shade cloth would be a little less damaged by heat.

[References used for the above discussion: Vegetables: Characteristics, Production and Marketing by Lincoln Peirce, Wiley & Sons, 1987; The Tomato Crop, Atherton and Rudich, Chapman & Hall publishers, 1988; personal conversation with Dr. Don Maynard, Florida Gulf Coast Research and Education Center.]

ECHO offers two types of tomato seed: open-pollinated disease-resistant varieties, and trial samples of a hybrid heat-tolerant variety. AVRDC (see p. 50) and other tomato breeders

are continually looking for more varieties which combine these traits, and we will make this seed available to you as it comes to ECHO. We also have varieties high in vitamin A. Tomato varieties always include a series of letters that represent their disease resistances: V for Verticillium wilt, F1 and F2 for Fusarium wilt races 1 and 2, respectively, T for tobacco mosaic virus, N for nematodes. In the tropics you want to see as many letters as possible.

The disease-resistant tomatoes developed for Florida are mixed together in a variety trial packet. We selected only open-pollinated ones (standard or non-hybrid, so you can save your own seed). Note that these were developed for our mild winter, so they are not selected for hot, humid weather. Their resistances are listed. Tropic is a stake-type tomato resistant to V, F, T, gray leaf spot, leaf molds, tolerant to early blight. Walter is resistant to F1, F2, gray leaf spot. Hayslip is a fresh market variety with determinant vines (i. e. do not need

staking) resistant to V, F1, F2, grey leafspot, resistant to blossom end rot, black shoulder, catface and cracking. Florida MH 1 is a high yielding variety that is very resistant to F1, F2, V, T, grey leaf spot, leaf molds, and graywall. Floradade is a determinant variety especially adapted to V infected alkaline soils. It is resistant to V, F1, F2, gray leafspot. If you only want to try one variety, we can package it separately for you; be specific in your request to us if that is the case. ECHO periodically updates the mixture of seeds in our variety trial as we hear of great successes with other varieties, so you may receive a different mix than what is listed here. For larger quantities of these varieties and many more (both standard and hybrids) suited to the tropics, we recommend Kilgore Seed Company, 1400 West First Street, Sanford, FL 32771, USA; phone 407/323-6630. They have good prices.

Ordinarily, there is little use doing a trial with hybrid seed if you could not import seed after the trial, so we will only send

hybrids if you specifically ask for them. However, some people have reported good success with planting a few tomato plants from a packet of hybrid seeds, then multiplying plants by cuttings. In that case, you would not need quantities of hybrid seed but could still benefit from the advantages that hybrids offer. Be sure to impress upon farmers that seed saved from hybrid fruits will not produce the same quality of fruit as the parent. We do not normally recommend hybrids because growers cannot save their own seed, but it is best not to be too dogmatic. There may be many situations in which purchasing seed will make economic sense if farmers can get a significantly higher price for out-of-season tomatoes or if for the first time large tomatoes were available. Also, because many superior genes are in hybrid plants, you might use them in developing a plant just right for your location by selecting the few outstanding plants each year.

'Solar Set' is a fresh market hybrid tomato that sets fruit



moderately well under high temperature (92 F [33 C] day, 72 F [22 C] night) and high humidity conditions. It was developed by Dr. Jay Scott at the University of Florida to extend the tomato season by a few weeks at either end of the normal season. It was not developed to produce throughout our terribly hot, humid summer, and in fact succumbs rather quickly to disease in the summer. The hope is that it will produce tomatoes a few weeks earlier than other varieties, bringing a superior price. Presumably it might also extend the season into somewhat warmer weather, although the premium price for end of season tomatoes will be less than that commanded by the first tomatoes of the year. This tomato is described as having large fruit with few defects even under adverse weather conditions. 'Solar Set' does not flower earlier than other cultivars, nor do fruit ripen more quickly. The improved earliness is entirely a result of a greater number of fruit which set early in the plants' development. It is resistant to Fusarium races 1 and 2, Verticillium, and gray leafspot. It is

apparently not resistant to nematodes. ECHO's experience is that it is more prone to disease than several other tomatoes, as we might expect from the few types of resistance listed for it.

'Solar Set' is distributed by the Asgrow Seed Company (4420A Bankers Circle, Doraville, GA 30360, USA; phone 800/234-1056; fax 770/416-0108). We spoke with Tom McBride at Asgrow about the variety. So far results have been very good in areas where tomatoes flower at high temperatures. 'Solar Set' is a determinate variety, unlike many of our readers may be used to (called indeterminate). In other words, relatively short plants will flower and set fruit for a relatively short period of time (30-40 days), but they fruit heavily and will do a good job of holding what fruit does set. While the tomato is a warm season plant, there is a point where it may be too warm for good germination (probably around 100 degrees). Because this is a hybrid, the seed is relatively expensive. Asgrow's

smallest unit in 1996 is 2000 seeds, which costs about US\$30.

ECHO can send you a trial packet to test them; if they are very successful, you may purchase a large quantity of seed from Asgrow or reproduce plants by cuttings. ECHO has obtained one of the larger cans and will send as many seeds as you want for \$1.50 per 100 seeds, including postage (count approximate). Before deciding to test them, remember that difficulties in obtaining smaller quantities of seed may make a trial of little interest to you.

The Tomato Growers Supply Company (P.O. Box 2237, Fort Myers, FL 33902, USA; phone 941/768-1119; fax 941/768-3476) has a huge selection of tomato varieties, including the productive 'Heatwave VFFA' hybrid (also determinate) which yields best when daytime temperatures are 90-96 F (32-35.5 C). They feature many heirloom varieties especially noted for disease resistance, if that is your main problem in growing

tomatoes. Processing types are also mentioned. Their catalog lists several pages of sweet and hot peppers as well.

**TOMATOES RESIST FLOODING IF GRAFTED TO EGGPLANT.**  
The AVRDC (see p.50) in Taiwan is interested in improving tomato harvests during the hot, humid part of the year when supply is short and prices are high. A special problem can be flooding during tropical storms.

Scientists noticed that eggplants which grew next to tomatoes survived a flood that killed the tomatoes. Simple experiments showed that they could easily graft tomato onto the eggplant rootstock. (They were not able to graft pepper to eggplant.) This led to trials in 1993 in which a tomato variety selected for its ability to produce in hot weather was grafted to eggplants. (Their choice was Taichung ASVEG #4.)

"Flooding, which occurred after the first harvest of tomato,

killed ungrafted plants whereas all tomato:eggplant grafts survived to produce more fruit. Early flooding (at 32 days and 40 days after transplanting) did not diminish growth and yield of the control.... This agrees with our observation in other species that early flooding does not necessarily result in plant mortality. Young root systems probably recover following flooding due to their superficial distribution near the soil surface which dries out first when flooding ceases."

The eggplant should be sown first and the tomato seed planted as the growing point of the eggplant appears above the cotyledons (2-3 weeks later). If necessary, tomato scions (budwood) can be kept in the refrigerator for up to two weeks, but must be wrapped with newspaper and covered in a plastic bag. (The same is not true for eggplant scions.) Tomato scions were made when the plant reached the three true-leaf stage by cutting at an angle of 30.

Simple rubber tubing, of the type used for bicycle valves, was used to hold the scion onto the stock. The tubing was cut at the same 30 angle. Then the rubber tubing plus scion were slipped onto the cut surface of the eggplant stem. Lining the angle of the cut of the scion with the angle of the cut on the tubing helps to correctly position the scion/rootstock surfaces. They can graft 150-200 seedlings per hour. To reduce grafting costs, they are experimenting with pinching the tops to form two stems so they can plant farther apart.

The plants were kept at 85% relative humidity. The tubing was cut 3-7 days after grafting so as not to restrict stem growth. At the same time plants were removed from the high humidity conditions and hardened off before transplanting. Thanks to Dr. David Midmore at AVRDC for supplying the picture and details from their 1993 annual report. For a copy of the article, write him at AVRDC, P.O. Box 42, Shanhua Tainan 741, Taiwan ROC.

WAX GOURD (*Benincasa hispida*) or Chinese wintermelon is the best cucurbit for seed oil in the hot, humid tropics. The large fruit (ECHO has grown some a meter long, and they are reported to twice that) has crispy white flesh, and its waxy coating helps give it a long storage life (up to a year without refrigeration). Young gourds are used like chayote, in stretching soups and stews. In China, mature gourds are used as soup pots: they are hollowed out and filled with soup ingredients, "capped" with the cut lid of the gourd, and steamed for up to six hours. Wax gourd prefers high temperatures and moderate rainfall; it does not do well in very high humidity. Hand pollination aids fruit production. Unlike other cucurbits, wax gourd does not contain vitamin A. It has few pests and diseases in most areas.

HAVE YOU TRIED WINGED BEANS, *PSOPHOCARPUS TETRAGONOLOBUS*? There has been so much promotion of the winged bean that I find myself thinking all of our readers know

about it. However, it is too important a plant to fail to bring it to your attention. This legume will vine up a four-meter pole. Nearly all parts are edible and high in protein. The leaves can be cooked like spinach and are quite tasty. The long four-sided pods with serrate "wings" running the length of the corners can be eaten like green beans. The dried seeds are the nutritional equivalent of soybeans. Fried flowers taste like mushrooms. When production is over, the stems can be fed to cattle, and most varieties have edible tubers that contain up to eight times the protein of an Irish potato.

The winged bean is native to the Asian tropics. When I have tried growing green beans during the hot, humid Florida summers, they have always been killed by disease or insects before they could produce pods. Winged beans, on the other hand, seem to resist almost everything except nematodes if well fertilized and watered.



We can send you seeds of a few varieties and a short technical note on the cultivation, preparation, and nutritional value of winged beans. Most varieties only bloom during short days, so they do not bloom and produce pods in Florida until mid-October. On the other hand, there are a few day-neutral varieties that get excellent yields right through the long days of summer. If you are far enough from the equator that this can be a problem, request the day-neutral seed from us. For others, we will send a selection of perhaps four regular varieties.

Winged bean seeds need to be scarified before planting. Alan Lee had less than 50% germination a month after planting his winged bean seeds. "I dug up the ungerminated seeds and nicked them all a few times with the corner of a razor blade, then replanted them. Within a week several had germinated and I expect more." Seeds will not germinate until they have absorbed water. Scarification softens or opens the seed coat so

water can be absorbed. Nick the seed with a knife or file or strike it across cement as in striking a match. Some seeds are soaked overnight. (Leucaena seeds are put in water that has just been boiled then left overnight. If you have any hard seeds that fail to germinate, it is possible the seed may still be viable. It may need to be scarified.)

After fourteen years of growing winged beans and distributing seed, we have come to believe that their potential has been overstated. Only very special recipes make the dried seeds appealing in taste. Pods are acceptable to the North American taste, but other beans are usually preferred. Leaves and raw flowers are quite good but probably limited to household use. No one at ECHO cares much for the tubers. (If the beans were propagated by tubers year after year, as is the practice with some other beans, it is possible that they might develop more in size and be more useful, although the texture might deteriorate.) Our impression from our network is that no one

has had a major success introducing winged beans. In its countries of origin, winged bean products continue to be popular. It is worth trial for its many virtues, but do not expect as much of its market potential as early reports indicate.

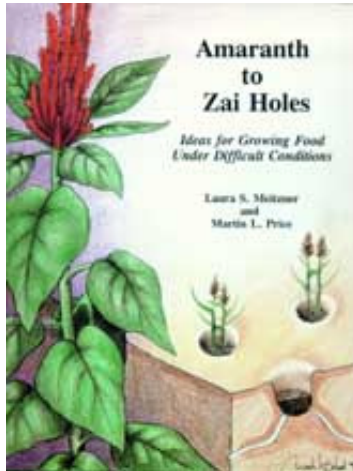


[Home](#)-immediately access 800+ free online publications.  
[Download](#) CD3WD (680 Megabytes) and distribute it to the 3rd World. CD3WD is a 3rd World Development private-sector initiative, mastered by Software Developer [Alex Weir](#) and hosted by [GNUveau Networks](#) (From globally distributed organizations, to supercomputers, to a small home server, if it's Linux, we know it.)[ar.cn.de.en.es.fr.id.it.ph.po.ru.sw](#)

---



Amaranth to Zai Holes, Ideas for Growing Food under Difficult Conditions (ECHO, 1996, 397 p.)



- ➔ □ 3: Staple crops  
    📄 (*introduction...*)
- 📄 Grain crops
- 📄 Pulse crops
- 📄 Root and tuber crops

## **Amaranth to Zai Holes, Ideas for Growing Food under Difficult Conditions (ECHO, 1996, 397 p.)**

### **3: Staple crops**

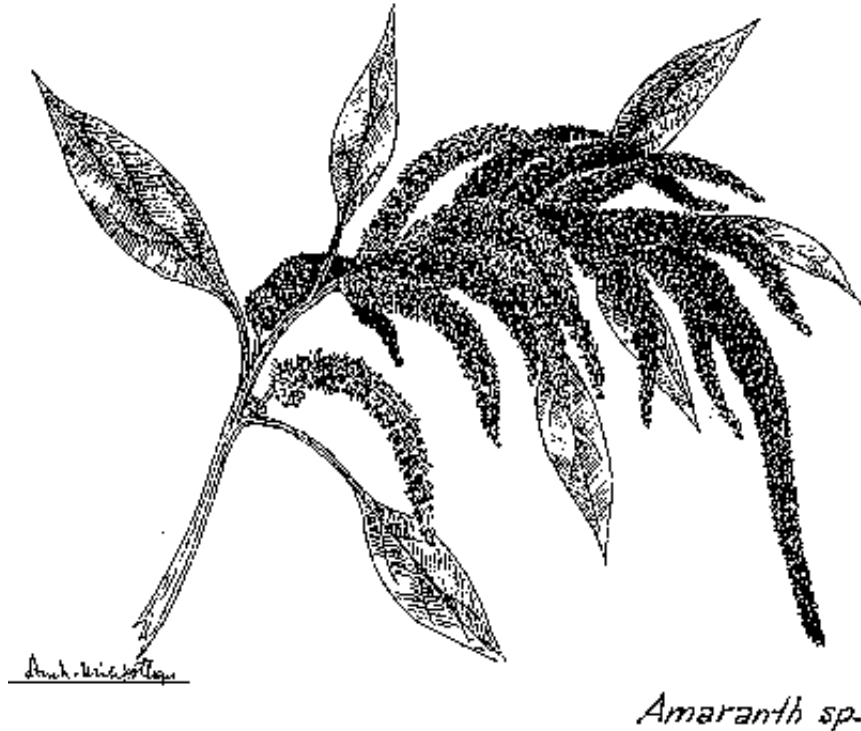
Staple crops are those which are most common in people's diets. Large expanses of land are dedicated to growing these foods, compared to the smaller areas planted in fruits and

vegetables. In the third world, the staples are often a starch (grain or root crop) and a pulse (dried legume seed, beans). The starch gives energy and a feeling of fullness in the stomach, while the pulse provides protein.

These crops are so important to so many people that many have spread far beyond their centers of origin; many types of cassava, corn, rice, soybeans, and pigeon peas are grown around the world. Major research centers devote much of their resources to studying and improving these crops. Other crops, such as amaranth, quinoa, and tepary beans remain localized, but they hold great potential for thriving in other places with similar conditions. ECHO's focus is on these little-known plants and some varieties of the common crops which have special characteristics.

## **Grain crops**

**AMARANTH SEED.** Amaranth grain, corn and beans were probably the primary foods of the Aztecs. The Aztecs unfortunately practiced a religious observance in which they would mix blood from a human sacrifice with popped amaranth grain. They formed this into a statue of a war god, worshiped the statue, then ate it. The Conquistadors considered this a mockery of the eucharist (communion) so banned both the religion and cultivation of the grain in 1517. Amaranth has existed primarily as a wild weed since that time.



## Amaranth seed

Amaranth received much research attention in the 1970s and 80s because: (1) it is more resistant to drought than corn, (2)

it does fairly well in nutrient deficient soil, (3) it produces yields that compare favorably with corn and rice, (4) the grain is high in protein of unusually high quality, and (5) the leaves also have a good balance of proteins and may be cooked like spinach. Much of the research was done by Rodale Institute (known for their many publications, including Organic Gardening magazine). They enlisted thousands of readers to do backyard experiments with different varieties of amaranth that they brought in from around the world. (This is a model for the kind of world-wide data we hope to gather as you report back to us on the seeds we send you.)

The protein is high in lysine, which accounts for 5% of total protein. It also has a very high "chemical score," a calculated value in which the higher numbers are the more perfect match for ideal human nutrition. For example, the chemical score for amaranth is 75-87, corn 44, wheat 57, sorghum 48, peanut 52, soybean 68, cow's milk 72. However, I have read results of



feeding trials with rats where they did not do well at all on a corn/amaranth diet compared to corn and soybean. There are some anti-nutritional factors in raw amaranth that limits its use as a feed. Cooking improves this. Other drawbacks include small size of the seed that makes it difficult to thresh by machine and oxalic acid in the leaves that might tie up too much dietary calcium if eaten frequently in high amounts. You may request a summary of nutritional and cultivation information from ECHO. (See the chapter on Human Health for a perspective on nutritional limitations of amaranth.)

When evaluating amaranth for your area, you should try more than one species and variety, because the variability is considerable. A few of those we grew this year looked absolutely horrible, while others were truly beautiful crops. *Amaranthus cruentus* and *A. hypochondriacus* are grown primarily for their grain and *A. tricolor* for its leaves. Leaves of any variety can be eaten, however. Doug and Ruth Welcha are

trying several of these varieties in Zaire. They just wrote that one variety (ECHO's #81-039) that they received earlier from Rodale grew 7 to 8 feet in composted soil. "Most of our neighbors demanded seeds, so it has been distributed near and far. But they are using it as a vegetable." This was one of the most prolific grain types for us.

Lloyd Rowlands sent us these comments from Zaire: "I planted two varieties of *Amaranthus cruentus* that I got from ECHO. I was pleasantly surprised by the yield. I gave a small quantity to my workman to try cooking. He tried it roasted-awful. Then he tried cooking it like rice-and asked me for seed! Variety 81-037 out-yielded 81-039. They were sown December 3 and harvested in March." ECHO has many varieties of amaranth seed, both types grown primarily for grain and those grown for their edible leaves. Please indicate with your order which type of amaranth you wish to try; we will send several varieties.

**BUCKWHEAT: EDIBLE LEAVES, SEED SET, SUCCESS, AND A RECIPE.** In the chapter on Domestic Animals we mention the experience with buckwheat, *Fagopyrum esculentum*, reported by John Trossel. He said this quick-maturing crop can be harvested two months after planting. Seed that we sent to a lower elevation (about 4,000 feet) in Honduras also reportedly did well. The newsletter HortIdeas quotes from an Indian journal that the leaves of this "broad-leaved 'grain' with remarkable soil-building abilities are edible. In fact, they are eaten regularly by people living in the higher ranges of the Himalayas. They are simply cooked with seasonings in boiling water for a short time. The leaves contain 4.5% protein on a fresh weight basis and are reasonably high in calcium and iron."

Buckwheat does best in cool and humid climates and is definitely not suited for the tropical lowlands. If you work at an appropriate site, we can send you a small packet to get

started. Poultry can eat the seeds whole, but for other animals it must be ground. Some of our readers, wanting to make a flour for human use, have given up on buckwheat because it is difficult to prepare into a pure flour when grinding. (If you have had experience preparing buckwheat flour, please share it with us.)

Kevin Hendricksen with the Peace Corps in Honduras wrote, "I planted buckwheat at 1500 m in early June in an area that receives 1000 mm rainfall. The plants grew quickly, flowered in about five weeks, reached a height of 12-15 inches. But the seeds produced were empty and did not sprout when planted. I made another planting of the original seed from ECHO in July with the same results." We asked Dr. Obendorf at Cornell University for some ideas on what may have caused the empty seed. He said that the optimal temperature for flowering and early seed set of buckwheat is 18 C; at 25 C, there is 40% loss of seed set and seed weight. The plants flower over a

period of about 6 weeks, but most of the seed set is during the first 2-3 weeks of flowering. Hollow seeds are probably those which are set late and form seeds which do not fill in. Under temperature stress, the early flowers will abort. Later flowers, however, may set seed, but it will be sterile. Other possibilities include inadequate pollination by bees or drought sensitivity.

Bill Lewis from Ethiopia visited ECHO and gave a good report on buckwheat seeds he obtained from our seedbank. When his family left Ethiopia, they left some plants nearly ready for harvest, and they were eager to see how the plant was used in their absence. He returned to Africa and sent this update: "We only had a few months to try it at about 5000 feet. We left our seed with church members when we went on furlough. We found that they love it. By adding a little wheat flour or oil they say it is as good as anything they have. I have some church property now with water available, so I will grow buckwheat continuously until the next rainy season for seed.

We are really excited about the possibilities! The buckwheat here matures in 9-10 weeks and is prolific. The bees really love it. We will also be trying other things-even your chaya!" He also asked for recipes.

Martin Price offers this family recipe for buckwheat pancakes. Growing up in Ohio, we had buckwheat pancakes almost every morning from the time the weather cooled down in the fall until it became warm again in the spring. The reason it required cool weather is that we fermented the buckwheat on the cool porch or in the sparsely heated kitchen. To start, we mixed buckwheat 50:50 with wheat flour, then added some yeast and enough water to make a thick paste. By the next morning it had expanded to 2-3 times its original size. We then added enough water for a nice consistency for pouring pancakes. We never liked it the first morning, but ate it anyway. That night we added more of the buckwheat/wheat flour mix (but no more yeast) and the process was repeated.

After the third day, the pancakes were absolutely delicious and gave a wonderful aroma when cooking. People who have eaten buckwheat pancakes from a mix (not fermented) do not know how good the sourdough approach can be. It is like a totally different food, and it is very filling in a pleasant way.

**NEW VARIETIES OF HIGH-LYSINE CORN SHOW PROMISE FOR THE SMALL FARM.** A variety of corn that contains much higher concentrations of the amino acid lysine than normal corn was developed by Dr. Ed Mertz at Purdue University in the 1960s. Lysine is the essential amino acid that is most limiting in diets composed mainly of cereals. One way to get extra lysine is to mix cereals with beans. The high-lysine corn, however, would be much more nutritious than regular corn for folks or animals that do not have a good mixture of legumes with their corn.

The high-lysine corn has not been widely accepted because its yields were inferior and the texture was not as acceptable for

human diets in many countries. Dr. Mertz visited ECHO on his way home from the International Center for Improvement of Wheat and Maize (CIMMYT) in Mexico. He was quite excited because CIMMYT had just completed yield trials in several countries with some new varieties that have equaled or outperformed the best open-pollinated varieties and which have the preferred texture.

Open-pollinated corn is the kind farmers plant year after year using seed that they harvest (as opposed to purchased hybrid corn). Most of you know that if farmers save and plant their own seed the next year from hybrid varieties, subsequent yields can be variable and much less productive. CIMMYT is to be congratulated for concentrating on open-pollinated corn, which is more appropriate than hybrid corn for those farming at near subsistence levels. If there is no sacrifice of yield, high-lysine varieties should be seriously considered for the small farm. Human and animal health would both be



improved. Some farmers in the United States claim that they save \$2-10 per hog when they feed high-lysine corn, mainly because it allows them to reduce the amount of soybeans in the diet by up to 25%. They also claim fewer veterinarian expenses. (I have seen no scientific studies on either point.)

If you want to try the new corn, you should be cautious about a few things. First, an unusual trait of the high- lysine corn is that if it is pollinated by normal corn the crop that is harvested will not be high in lysine. Therefore, if it were introduced to an occasional small farm which is immediately surrounded by fields of regular corn, the extra nutritional benefits might not be present. All farmers in an area should agree to grow the high- lysine crop unless fields were somewhat isolated. Second, there is risk in changing all of a farmer's crop to a single new variety. Quite likely the local varieties have developed resistances to disease and insects common to the area. Although the new varieties have no doubt been

developed with resistance to common tropical stresses, there is some risk (and scientific loss) if the old varieties are no longer grown.

The director of the Maize program at CIMMYT told us that it would be best if ECHO's network would write CIMMYT for seed, rather than sending seed to ECHO for redistribution. This would enable them to send appropriate types. They have both highland and lowland varieties and also different grain types and maturities, so tell them something about your climate, altitude, length of season and any preferences as to type and texture of the corn so they can make the best choice. Write CIMMYT, Londres 40, Apdo. Postal 6-641, Col. Juarez Deleg. Cuauhtemoc, 06600 Mexico, D.F. MEXICO.

DROUGHT-TOLERANT CORNS FROM 'PLANTS OF THE SOUTHWEST' CATALOG. Posole Corn: "Large, plump ears on vigorous, drought-tolerant plants. The traditional variety of

dry dent corn for making posole, the hominy and one of the finest dishes of the Southwest. 100 days." Papago: "Small, slender cream-colored ears on this drought-tolerant corn adapted to the extremely arid region of southern Arizona. Larger in wetter climates or with regular irrigation. Grind into meal for tamales. Excellent for harsh, dry sites. 80 days." Buhrow's White Desert Sweet Corn (ask for it even if not listed in their catalog): "A new cross of papago with a white corn to produce a sweet corn that will open pollinate between 90-100 F. It is remarkably drought tolerant and has been known to bear when deeply watered only 3 times in a season, but your yield will be greater with more frequent waterings. Grows 5-9 feet with 6-9 inch ears." [NOTE ON CORN: We bought this from a commercial seed company, so it should be disease free. If corn is important in your area, be watchful and destroy the plants if any new disease should ever appear.] ECHO can send you a small packet to evaluate. Though you can save your own seed, it is best to have a minimum population of perhaps 200

plants in a field to prevent inbreeding. You can later order larger quantities from Plants of the Southwest, Agua Fria, Rt. 6 Box 11A; Santa Fe, NM 87505, USA; phone 505/471-2212; phone orders 800/788-7333; fax orders 505/438-8800 (\$20 minimum). Their catalog features many other drought-tolerant corns and plants you may wish to try.

DOING YOUR OWN CORN (MAIZE) IMPROVEMENT. Bob Short in Mexico teaches farmers to improve their own open-pollinated (not hybrid) corn varieties. The people already select the best ears for seed, but the selection is made from a pile after the harvest. Selection based on ear size only can cause more problems than you might think. This brings up an interesting story.

In the early 1900s in the United States a popular magazine, "Wallace's Farmer," and a professor at Iowa State University promoted corn competitions. These became annual events all

over the midwest. Judging was based on a vision of the ideal corn: uniform ears, 10 inches long, with even rows and deep kernels shaped like a keystone. At one of the professor's talks a 16-year-old boy (the editor's son) asked whether seed from the ideal ear would produce more corn than any other. "Of course," he replied, though he had not tried it. The boy's persistence made him nervous, so he collected 25 ears of the best show corn and 25 of the poorest. The highest yield came from an ear no corn-show judge would look at twice. As a whole, the highest-ranked show ears produced less than those that ranked lowest. The boy went on to school and later formed what became the largest corn seed company in the world, Pioneer Hybrid, and eventually was Secretary of Agriculture.

Bob finds that even after selecting the best ears for seed, about half of the plants produce a poor ear, if any at all. Bob decided that the basic traits that he wanted were present in

one plant or another in the field of "criollo" corn, though not necessarily on the same plant. He wrote, "Our method of selection is simple. The first thing we do is de-tassel the poor plants before pollination. This ensures that reasonably good plants will be the male parents of the corn. Then we select the ears to be kept for seed in the field. We take from the best plants which produce a good ear, taking into account the quality of the roots, stem, disease resistance, leaf area, etc." The important difference in this method is that good ears come from plants that are also known to be good.

"We have seen problems of inbreeding, so now recommend that seed come from fields that are at least half a hectare in size and that a minimum of 400 ears be selected. The selected ears are shelled and the seeds are thoroughly mixed together and saved for the next planting."

Bob says that they have definitely improved the quality of

their own corn. It is difficult to convince farmers to change to it though because improvement is too slow to be seen quickly. A few are beginning to try it and he hopes that in 5-10 years it may be widespread.

I asked Dr. David Unander, a plant breeder on ECHO's Board of Directors, to comment. Highlights of his reply follow. "How many ears should one save to avoid inbreeding? Plant breeding texts and research suggest a minimum of 30 plants to avoid serious inbreeding, but much more is better. Unneeded seed can always be eaten. The extent of inbreeding is a function of the percentage of the population saved and will increase substantially if much less than 10% of the harvest is saved and mixed in the seed bin."

Dave suggests a way to further improve the technique. "Because differences among plants depend on the local spot in which the corn plant is grown, mentally divide the field into

little blocks of 10-20 plants each (or more in a larger field). Be sure to select the best ear or ears from each of these imaginary blocks. Plants with mediocre genetic traits may have done well just because they grew in an unusually fertile spot, and plants that are outstanding may have done poorly if they grew in a poor part of the field." [This would also help to keep in your pool of seeds traits that would enable the best performance possible in those poor parts of the field.]

A special merit of Bob's method is "that he has thought out exactly what he wants to select: he has a mental picture of what a good corn plant would be like for his area. This is one of the most important things to establish before beginning any breeding program."

QUINOA, CHENOPODIUM QUINOA, IS A NUTRITIOUS GRAIN FROM THE ANDES.



"While no single food can supply all of the essential life-sustaining nutrients, quinoa comes as close as any other.... It holds exceptional promise as a weaning food."1 This crop was a staple in ancient times, second in importance only to corn in the Incan empire, and it is still an important grain crop in Bolivia, Chile, Ecuador, Peru, and Colombia. "Its grain is rich in protein and contains a better amino acid balance than the protein in most cereals. ...Today it is made into flour for baked goods, breakfast cereals, beer, soups, desserts and even livestock feed. When cooked in water, it swells and becomes almost transparent. It has a mild taste and a firm texture like that of wild rice.... Traditionally, quinoa is prepared like common rice or is used to thicken soups, but some varieties are also popped like popcorn."

"Quinoa has demonstrated value as a partial wheat-flour substitute for enriching unleavened bread, cakes, and cookies. Blends of 70% wheat and 30% quinoa flour produce fully

acceptable loaf breads."2 Quinoa is called a "pseudocereal" because its use is similar to that of cereals but the plant is not in the grass family. Seeds are produced in large sorghum-like clusters and may shatter easily. They contain 58% starch, 5% sugar, 12-23% protein and 4-5% fat. It is a hardy plant, growing to 0.5-3 meters tall, maturing in 5-6 months with short day length. A drawback is that seeds of most varieties contain saponins, which impart a bitter flavor unless washed out in cold water or milled out.



Quinoa has an exceptionally nutritious balance of protein, fat,  
oil and starch

"Quinoa has an exceptionally nutritious balance of protein, fat,

oil and starch. The embryo takes up a greater proportion of the seeds than in normal cereals, so the protein content is high. Quinoa seeds average 16% protein but can contain up to 23%, more than twice the level in common cereals." According to *Underexploited Tropical Plants with Promising Economic Value*, quinoa may prove to be a better protein source than most of the true cereals. It is "high in the essential amino acids lysine, methionine and cystine, making it complementary both to other grains (which are notably deficient in lysine) and to legumes such as beans (which are deficient in methionine and cystine). Quinoa is higher than wheat, corn or white rice in iron (6.6 mg, 4.6, 3.7, and 0 mg respectively.), phosphorus (449, 224, 207 and 143 mg), and calcium (141, 36, 6 and 8 mg)."

Quinoa's large seedheads and broad leaves make it look something like a cross between sorghum and spinach. Visitors who see quinoa at ECHO before seed heads form almost

always think it is the (edible) weed lambsquarter, to which it is closely related. The leaves are eaten fresh or cooked. Nitrates and oxalates, high enough in some greens to be a health concern, are very low in quinoa leaves.

Quinoa has been grown almost exclusively in the Andean countries which were formerly part of the Incan empire. In the Andes, it is primarily a food of campesinos, although in some areas it is gaining popularity among wealthier urban classes who realize its nutritional benefits. The increased interest in these countries of origin is due in part to efforts of local governments and increasing interest in healthful foods, and in part to its growing popularity in western countries, where new, tasty and healthful foods bring a premium price.

Quinoa is known for its resistance to tough conditions. It will grow where corn will not because of cool weather and dry conditions. During a devastating drought in the altiplano in

1982-83, 66% of Bolivia's potato crop was lost, 25% of corn, 54% of barley, 44% of wheat, 34% of cassava but only 7% of quinoa. In Peru the figures were 27% potato, 6% corn, 26% barley, and 0% for quinoa.

There is great diversity in plant characteristics. "A classification based on ecotype recognizes five basic categories. (1) Valley type, grown in valleys from 2,000-3,600 m. Tall, branched, long growth periods. (2) Altiplano type, frost hardy, short, unbranched, short growth periods and compact seedheads. (3) Salar type, native to the salt flats in the Bolivian altiplano. (4) Chilean type, grown at low elevation sites between 34 S and 41 S in Chile, will flower even with long days. (5) Subtropical, located in intermontane valleys in Bolivia, intensely green plants that turn orange at maturity and have small, white or yellow-orange seeds."

Farmers and scientists in parts of the industrialized world

where weather in the summer months resembles weather in the Andes have been trying to develop quinoa as a crop since the early 1980s. Because they originated near the equator where days are short, most varieties are daylength sensitive (require short days to flower) and do not do well. However, there are varieties which grow near sea level in Chile where days are long. These have proved more adaptable to high latitudes.

A drawback to quinoa production and use on a small scale is that the seeds contain saponins in the seed coat, which cause the grain to be extremely bitter. They can easily be mechanically removed with appropriate equipment. Lacking such equipment, the grain can be rinsed or soaked in water to dissolve the saponins. However, it is more difficult to get a uniform product this way. I spoke with Dr. Duane Johnson at Colorado State University about quinoa and its potential. He had just returned from harvesting his experimental plots of

quinoa in Colorado.

Q. We know that the equatorial types require short days to produce seed but that Chilean types do not. Do Chilean quinoas actually require long days or are they day-neutral (produce in any daylength)?

A. They are day-neutral. That means that if ECHO sends Chilean seed to its network, it should not fail because of daylength. However, people in equatorial highlands would probably prefer equatorial types. They tend to have larger, white seeds; Chilean quinoas are smaller and colored. White seeds are generally softer and it is easier to remove the bitter saponins. Chilean types are harder and more extensive work is required to remove the saponins.

Q. The Chilean types are unbranched. Does that mean they should be planted more densely than equatorial types?



A. Yes. We plant 2 pounds/acre of equatorial seed but 5 pounds/acre with Chilean. That corresponds to a plant spacing of 3-4 inches (7.6-10 cm) and 2 inches (5 cm) respectively. Most farmers in Colorado use rows 16 inches (40 cm) wide, but some use 8 and others 20 inches (20 and 50 cm), depending on moisture. (If rainfall is limiting, having fewer plants with wider spacing will require less water.)

Q. What are the climatic boundaries beyond which quinoa has little potential? Will Chilean sea level types do well in tropical lowlands?

A. They have the greatest heat tolerance, but we don't recommend them where temperatures exceed 92 F/33 C, especially during the flowering period (July here in Colorado). We have quinoa growing from Finland to Australia, but mostly in temperate regions. Quinoa is very susceptible to downy and powdery mildew. It likes low humidity. Cool nights are

probably important, though I have no data to prove that. It does well here where temperatures average 80 F day, 45 F night (27 C and 7 C). It does not do as well in broad valleys where night temperatures remain rather high, though at 7,000 feet it does great even in valleys.

[NOTE: Because it flourishes at high altitudes (2500-4000 m), we thought we might have a chance of growing quinoa at ECHO in southern Florida during the cool winter season. It has exceeded our expectations in some years, growing quite vigorously and forming grain. We are interested in examining it more closely to determine whether it has potential for a much wider range of climates. Dr. Russell Seibert at the Marie Selby Gardens told me that he thinks he has heard reports of it growing quite successfully in Alaska. An association, Sierra Blanca Associates, 2560 S. Jackson, Denver, CO 80210, USA, has been formed for its promotion and trial. It grows best where maximum temperatures do not exceed 90 F (32 C) and

night temperatures are cool.]

Q. Are there subtropical quinoas?

A. There are related species, mainly back garden types. They grow, for example, in parts of Mexico. [Ed: Can anyone give ECHO some seed?]

Q. I read that the equatorial quinoas grow so well in Colorado that they might make good forage.

A. Equatorial types produce tremendous biomass here, but we get no seed production. It could be used for forage only if we imported seeds.

Q. How complex is it to remove saponins at the "village" level?

A. It is pretty simple. Pillsbury Co. gave us a \$7,000 rice dehuller (a carborundum stone that spins and knocks the coating off, designed for 3rd world countries). It works even with the harder Chilean types, though they require 2 passes.

Once dehulled it tastes just as good. Actually I prefer the Chilean varieties, which to me have a richer, nuttier flavor. I find the equatorial types somewhat bland.

Q. Do the saponins give the color to the seed coat? If so, can you learn anything important by noting the color of the grain, e.g. whether birds might avoid it?

A. The saponins are buried in a pericarp, like the rind on an orange. Color does not really tell you anything useful. There is no correlation between color and bird resistance.

Q. What is the status of saponin-free varieties? Are they more prone to insect and disease loss?

A. We are currently investigating these varieties, but I have some hesitation after this year's results. Birds were definitely a more serious problem with saponin-free varieties-I'd estimate 30% loss to bird damage. This is in middle of a 150-

mile valley with no trees within 2 miles of the plots. But migrating birds found it (other grain fields had been harvested). [Ed: Has anyone noticed whether bird damage is a more serious problem in general on farms making heavy use of agroforestry techniques?]

Q. I read that in early trials in Colorado improved, selected varieties from South America did not do as well as less selected varieties. Presumably the loss in variability during the selection process lost some traits that were important in Colorado. So should I offer your selected varieties to ECHO's network or will they likewise perform less well than the original seed might have done?

A. We find that selected lines from South America aren't as good for us. The same may be true of our varieties when tried elsewhere. We have selected two: Apelawa and Colorado 407. I maintained the old original material, which would probably

be better for widespread preliminary trials.

Q. Is quinoa becoming commercialized outside the Andes?

A. About 500 acres are grown in Colorado and 200 each in Washington and Wyoming. It is processed and sold to health food industries. Until this year 50% was sold here and 50% went to Europe. This year 99% will be sold in the USA. Europeans are now buying from South America. Nestle invested \$5,000,000 in Ecuador in research in quinoa. Starch from quinoa is being used in synthetic cream products. The market for quinoa is increasing. Canada is becoming a dominant force, growing 2,000 acres last year.

Q. Where are the main places for seed of diverse types? Are Andean countries hesitant to share seed?

A. Ecuador and Bolivia are very helpful in exchanging seeds with us. INIAP in Ecuador has equatorial types; write Estacin

Experimental Sta. Catalina, Km 14, Panamericana Sur, Quito, ECUADOR; fax 593 2 504 240. For Bolivia you should go and see what you can find. [NOTE: ECHO has many of the lines used in breeding by INIAP, if you want to select from domesticated but widely varying strains. Dr. John McCamant, Sierra Blanca Associates, 2560 S. Jackson, Denver, CO 80210, USA, also gladly shares from his sizeable quinoa collection.]

Q. Do you have any final comments?

A. There is a southern Bolivian type that I like very much. But it requires a longer season than we have in Colorado (105 days). I like it because it has larger seed and a softer pericarp, but is day-neutral.

If you want to try growing quinoa in your area, write to ECHO for sample packets. Dr. Johnson sent ECHO enough Chilean quinoa seed to send small introductory packets to our overseas network. These should bloom under the broadest

range of day lengths (assuming that temperature and other conditions are right). We also have the virtually saponin-free commercial variety 'Tunkahun' from the highlands of Ecuador. Our seedbank has several other varieties you may try, if you are interested in doing a broad trial with quinoa. We do not consider quinoa worth trying in hot, humid lowlands nor where high temperatures are much over 92 F/33 C.

[This article relied heavily on the book *2Lost Crops of the Incas*, the National Academy Press, 1989, and an article *1"Quinoa: Grain of the Incas"* by David Cusack, in *The Ecologist* Vol 14: 21-31, 1984. David, an early member of ECHO's network, was shot and killed during a 1984 trip to South America to collect quinoa seed.]

**A FARMER'S PRIMER ON GROWING RICE.** This book was written at the International Rice Research Institute (IRRI) to help the progressive rice farmer understand "why and how the



improved rice varieties and farm technology increase production." The book answers questions such as why more fertilizer should be used in the dry season and how water depth affects seedling growth. It is clear and concise. The major part of each page is an illustration or diagram. Only a few words of explanation and clarification occur on the page. Some knowledge of rice production is assumed. For example, the mechanics of planting a seed bed, transplanting, harvesting, pest control and disease prevention are not covered. It does cover the life cycle of the rice plant in great detail and tells how the treatment of the rice plant at each stage will affect the final yield. Selected topics in the book are when and why to add fertilizers, factors affecting growth, factors affecting lodging, how to use yield components, control of weeds, carbohydrate production by the plant, use of herbicides and how to judge a rice crop at flowering. The book should be extremely helpful to an agriculturalist who is involved in training farmers. The illustrations and diagrams

could be enlarged and used in teaching. The revised 1992 edition (219 pp.) costs US\$3.25 plus postage. (The 1979 edition is available in Kiswahili for US\$2.75 plus postage.) Order catalog from Information Center, IRRI, P.O. Box 933, 1099 Manila, PHILIPPINES. Their catalog lists local suppliers around the world which charge less postage and give faster delivery. IRRI has an excellent catalog and is your best contact for questions related to rice. ECHO does not carry rice seed.

GIZA SORGHUM FOR FOOD AND FUEL. Dr. Axtell at Purdue University gave us a packet of seed of this special Egyptian grain sorghum and explained that in Egypt the stalks sometimes sold for more than the grain because of its superior burning characteristics. The grain is of good quality, though it can be damaged by rains near harvest. (As we have threshed it by hand, it seems that it is hard to remove all the "glumes" from the grain too.) Though we sent out several packets of seed in subsequent years, it was a long time before anyone in

our network reported any excitement over it. Paul Butz's report from Peru is both encouraging and humorous.

ECHO was only able to send a small packet. Paul wrote that only 6 of 16 seeds germinated. Then two of these died of some disease. Later goats got in and ate half of the remaining four. The two that were left produced seed heads-then birds ate most of the seeds. By covering the heads with plastic bags he managed to get 200 seeds. Unlike in temperate climates where sorghum is an annual, a stalk that is cut back in the tropics may tiller (send up new stalks). Each of the two plants sent up 3-5 new stalks which in turn produced seed.

The immediate purpose of Paul's work is to "produce fuel for firing bricks in this area" as well as for cooking. They were expecting to plant a hectare which they calculated would produce enough fuel for the brick operation, giving at least three cuttings a year. Write ECHO if you would like to try seed

of this sorghum.

"BIRD-RESISTANT" GRAIN SORGHUM. I [MLP] am especially pleased to make this offer because it relates to the subject of my three years post-doctoral research at Purdue University. Grain sorghum is one of the world's major cereals, grown primarily in locations which are just a bit too dry for reliable yields of corn. The plant looks like corn when young. Then a stalk emerges from the top of the plant on which a head of grain develops. Unlike corn, where the grain is protected by a husk, the sorghum grains are fully exposed. In some cases an entire field can be lost to birds.



bird-resistant" grain sorghum

There are two ways to protect the grain, neither very acceptable. One is to have the children or older people stay by the fields during the most susceptible weeks and scare the birds away. The other is to grow varieties which have a high

tannin content. I once led a trial in Puerto Rico in which regular and high-tannin sorghums were grown on 3 acres. My plans for measuring degrees of damage by birds were discarded because there was 100% destruction of the kind with no tannin. The high-tannin varieties scarcely lost a grain.

So why is tannin not a good option? Tannin is the substance in green fruits (e.g. persimmons or banana) that causes your mouth to pucker up. The tannin binds with proteins, causing them to come out of solution. If this happens in your mouth, the lubricating proteins of saliva are removed, resulting in the puckery sensation. In the digestive tract they may tie up proteins in the diet or, worse yet, digestive enzymes. The consequences are serious. In feeding trials with rats and chickens, the animals grow much slower, or sometimes even lose weight, with rations based on high-tannin sorghum compared to varieties with no tannin.

Farmers face a terrible choice. Grow regular sorghum and risk low yields due to bird damage or high-tannin sorghum and get good yields of grain that is very bad nutritionally.

Dr. Larry Butler at Purdue gave me the good news that Dr. John York at the University of Arkansas and Roger Bullard with the U. S. Fish and Wildlife Service have a sorghum with no tannin that birds seldom bother. Dr. Butler's feeding trials showed that it was as good a feed as any other sorghum.

Dr. Butler says, "In trials in Indiana for two summers the new variety was not damaged at all, whereas susceptible lines in the same fields were totally destroyed. However, one planting in Puerto Rico, where the sorghum was planted next to some millet (a common ingredient in bird feed), was wiped out. So in special cases it can still be damaged."

Trials have been conducted in Brazil, Kenya and Tanzania. You

might want to wait until a lot more research has been done. But if you would like to get in on a tiny trial yourself, Dr. Butler gave us enough seed to send you a trial packet. Plant a row in the same field as your other sorghum and see if there is a difference. I asked if it was important to plant in a separate location, thinking that perhaps the birds needed to learn that a particular patch of grain was not "tasty." He said that birds seem to be able to distinguish individual resistant sorghums right in the row. Be sure to let us know what you find. We will pass the results on to Dr. Butler.

Dr. York has just released the variety, called AR 3048. He said that no yield trials have been done. (I think it was released primarily for use by plant breeders.) It is a triple dwarf, which means it may only get to be knee high. The plants are just now blooming at ECHO at a height of about 3 feet (1 m). That does not mean yields will necessarily be low, as many commercial varieties are dwarf. Although the short stalks



mean that there is less danger of lodging (falling over) in wind, there will not be long stalks after harvest for other uses.

Dr. York reported a trial in which 2% of grain was lost during the "milk" stage of grain development to birds with AR 3048 and 86% for a control. There was some loss in that case after the grain was more mature ("dough" stage). He had earlier released another variety which proved to be resistant some years and not in others. There are a lot of mysteries in just what is happening and what is responsible for this "bird resistance."

If you are inclined a bit toward plant breeding, note that this bird resistance is a recessive trait. If you cross with another variety the seed will produce plants that are not resistant.

Saidou Jallow in the Gambia reported: "The bird resistant dwarf sorghum did absolutely well. I find no fault in it. Both

the people in my village and surrounding villages like it. I hope in the near future it will be widespread in the area because it has the following advantages: short duration, wind resistance, and less or no disease."

Dr. Butler did send this caution about the bird-resistant sorghum. In some parts of the world people roast sorghum, as with corn (roasting ears) in the United States. Larry cautions about consuming this variety fresh roasted. "The roasting would not detoxify the cyanogenic glycoside dhurrin, which seems to be responsible for its bird resistance. The levels of dhurrin are higher at the dough stage than in the mature grain. The conventional processing method (grinding and wetting and cooking) does eliminate the cyanide." He adds that in both Kenya and India he "was told that if food supplies are scarce it is better to have a small amount of sorghum than maize, because one is more satisfied and can work longer on sorghum. I presume slower digestibility is the reason." This

would assure a slow release of nutrients to the body over a longer period of time.

## **Pulse crops**

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 £15 including surface postage. Order from Publications Distribution Office, Natural Resources Institute, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK; phone 44-1634-880088.

**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.

"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.



## sweet lupin

In this century "sweet" varieties of lupins have been developed which lack the bitter alkaloids. In many countries these are 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 16 F (-9 C). The tropical lowlands would not be suitable for lupins because the seeds will not set if the

temperature is high during flowering (over 90 F or 30 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 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."

NUTRITIVE VALUE OF NUAS (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?

Nuas 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.

Nuas 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 C. Nuas 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 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 nuas appears to be



related to their high starch content. The high starch levels may also explain the 'filling effect' [appetite satisfied] nuas 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 nuas and other common beans, but in nuas 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 nuas 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 nuas (76.6% vs 79.1%). "Nuas stored at optimum conditions retain indefinitely their ability to pop. However, under market place conditions, nuas 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 nuas 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 nuas. 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.

RESEARCH ON NUAS (POPPING BEANS). The international research center CIAT in Cali, Colombia is working (on a small scale) with nuas. 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 nuas 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.

PIGEONPEA VARIETIES FROM ICRISAT. We often tell people that ECHO specializes in growing food under difficult 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, Patancheru, 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.**

<b>Constituent</b>	<b>Green Seed</b>	<b>Mature Seed</b>
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.

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. 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 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  $MgSO_4$  (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.

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. 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 trifoliolate 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

tepyary 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 8 C/46 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 Mayagez, 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 46 C/115 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.]

It is very important with tepary beans to try them at different times in the season to determine their best "window" in the

local climate. Do not give up on them if they don't succeed on the first try; planting again at a different time may produce better results.

Q. How easily can tepary beans be crossed with other local beans to impart disease resistance?

A. This is not possible at the field level.

Q. Are there other reasons why someone might want to grow tepary beans if they could grow common beans?

A. Tepary beans often produce at a different time of year than other beans, when it is too hot or dry to grow common beans. In addition, they are an excellent crop for drought insurance in areas with occasional dry years; people in such areas may want to maintain a plot of tepary beans in case the common beans do not receive enough rain. They may also be used as a green manure in some areas, although that is not their

primary use now.

Q. Do tepary beans have potential as a green manure/cover crop for arid zones? (ECHO has heard of this in the Caribbean.)

A. Since tepary bean is a short-lived annual, it doesn't have as much potential as a cover crop as some other plants would. One of its great potential uses may be in an intercropping system with sorghum during the dry season.

Dr. Miklas has sent ECHO seed of these eleven varieties to distribute to our network. We have combined them according to color (white, grey, black, yellow-brown, and red). When ordering seed, please indicate the dry bean color preferences (if any) for your region.

We and Dr. Miklas (USDA-ARS, P.O. Box 70, Mayagez, Puerto

Rico 00681) are very eager to hear how these varieties perform for you and are accepted in your area. ECHO also has larger-seeded virus-free native varieties from Arizona (white and yellow). Our source is Native Seeds/SEARCH, 2509 N. Campbell Ave. #325, Tucson, AZ 85719, USA. They carry 18 varieties of tepary bean; write for their seed catalog for more information on these and many other dryland plants. Please note that people with year-round humid weather would probably be wasting their time with this trial. For example, we cannot grow tepary beans at ECHO in the summer.

WINGED BEANS. See pages 70-71.

CAUSES OF BEAN BLOSSOM DROP. James Chrisantus in Kenya asked why all the blossoms fell off his winged beans, thus producing no beans. ECHO asked Dr. Andrew Duncan of Oregon State University. His reply concerns beans in general. "The two major causes of bean blossom drop are high

temperatures over 90 F (32 C) and drought. Beans selected for temperate zones are more sensitive than those native to the humid tropics and sub-tropics. If beans have been growing under moderate (very favorable) conditions, then the imposition of stresses is even more damaging." Drought stress can occur even when the soil holds considerable water. For example, when soil moisture levels are at half of the field capacity [soils contain half as much water as they can hold without being flooded], and relative humidity is low (<25%), even a 5 mile per hour (8 km/h) breeze can cause moisture stress. "Root damage by diseases, insects or deep cultivation should also be checked. A long shot is improper use of pesticides. Beans are very sensitive to the 2,4-D type herbicides, even the vapors from a distance. Solvents included in insect sprays can damage blossoms and leaves."

## **Root and tuber crops**

SWEET POTATO CROP PRODUCTION BULLETIN, by Dr. Frank Martin. Dr. Martin is one of the leading sweet potato breeders, so it is fitting that he treat the subject of his first scientific love. The following is a condensed version; write ECHO for the complete bulletin.

Sweet potatoes (*Ipomoea batatas*) are the sixth or seventh most-produced food crop in the world. What makes it such a great crop? It is relatively easy to grow, is relatively free of pests and diseases, has relatively high productivity, and is always good food, principally starch, some protein and vitamin C, and, in orange varieties, rich in vitamin A. In addition, the young leaves, rich in protein and most vitamins, are also good food. Furthermore, both sweet potato tubers and vines are excellent animal food.

Its ability to produce in poor soils make it an especially good crop for poor tropical soils where fertilizer is not available. If



the leaves are also used as food, sweet potato will probably produce more nutrients per acre than any other crop under those conditions. (Cassava also produces well on poor soils and also has both edible roots and leaves. Its main advantage over sweet potato is drought tolerance. Sweet potato has the advantage in nutrients because polyphenolics in the cassava leaf combine with protein during cooking and reduce the amount of protein that is digestible.)

**PRINCIPLE USES OF SWEET POTATOES.** Leaves can be harvested during the second and third months of production. Only the tender stem and young, not-fully-developed leaves should be taken. The leaves and stems are boiled for 15-20 minutes. You are already familiar with recipes for boiled or baked sweet potatoes. (By the way, baking converts part of the starch to the sugar maltose, thus increasing sweetness.) There are other, less familiar, uses. The mashed pulp of boiled sweet potato can also be used as a partial substitute for wheat

flour in baked products such as pancakes, cakes, flat breads, cookies, pies, fritters, or even bread. It can also be processed further, as you will see.

To make osmotically modified boiled sweet potato, the peeled and trimmed sweet potatoes are cut into thin (1/8") slices, placed in water 2 hours (moved once in a while) and then boiled. The products will be clearer, less sweet, and milder than those made from untreated sweet potatoes. (What is happening chemically is that the enzymes and substrates responsible for polyphenolic oxidation are partially lost, as well as some of the sugars.)

Sweet potato flour is much more difficult to make than potato flour because the reducing sugars readily released from the starch combine with free amino acids to produce disagreeable colors, odors, and flavors. To avoid this the peeled sweet potato can be shredded, and the shreds immersed in water 2

hours. This process works better if the water is changed 2-3 times. The shreds are drained and then dried, first in the shade (with air movement or wind) and later in the sun (in some cases, drying over the stove or in an oven will be necessary). The brittle shreds are easily crushed to flour, or this can be done rapidly in a household blender. The flour can be stored for 6 months or more in sealed containers. It can be used as a substitute for wheat flour in the following amounts: 100% in white sauces, 25-50% in cookies, cakes and flat breads, and 15-20% in breads. From the water, starch can be recovered (see below).

Starch can be produced by grinding the peeled sweet potato in a mill or blender as finely as possible, and mixing with 5-10 times its weight in water. The starch settles out, and the water is carefully poured away (this can be used as pig feed). The starch is then mixed with water 1-3 times more and the process is repeated. After the last settling the water is

carefully drained and the starch is dried on a metal surface in the sun. It can be used as is any starch, such as corn or potato starch, and can be stored in sealed containers for a year or more.

A breakfast food similar to "cereal" can be made from any sweet potato. The sweet potato is grated (not as finely ground as for starch), suspended in water, and filtered through a cloth. The liquid is saved for starch, the residue is suspended 1-3 times more in water, and filtering is repeated. The portion of the sweet potato that does not pass through the filter is then dried and lightly toasted on a hot plate (over the fire). The toasting is very delicate. The product must be stirred and turned almost continuously, and should not become sticky and jellified. The toasted product can be stored in sealed containers and eaten with milk without further cooking, or can be used much like starch or flour, imparting its characteristic flavor.

**CULTURE OF THE SWEET POTATO.** Sweet potato is a hot weather crop. It is difficult to imagine an earthly environment that is too hot for sweet potato. In general, hot temperatures only speed up its growth. On the other hand sweet potatoes will survive at any temperature above freezing, and are very productive at temperatures that are comfortable for humans as well.

Depending upon variety, sweet potatoes may be ready for harvest after 10 weeks or may require up to 9 months in the field. The majority of the varieties can be harvested after 4 1/2 months in the field. Cool conditions can extend the needed growth period to 8-9 months. Early varieties (10 weeks) are in the process of development. Sweet potatoes from an individual planting may be harvested as needed over a three to four month harvest season.

If the soil is well aerated with medium texture the sweet

potatoes need not be planted on ridges. They can be produced in heavy soils if formed into ridges for drainage and increased aeration. Sweet potatoes are often grown in sandy soils. Too much nitrogen results in abundant foliage and low and/or late yields. They can tolerate light drought in the second and third month of growth, and often fairly severe drought in the fourth or fifth month.

There are too many varieties to try to describe them all. Because of all this variation it may well be worth your while to collect several varieties within your country for local variety trials and preference tests. It is probably more useful to talk about some of the differences found. Internal color is the first difference you will see: white varieties (no vitamin A), yellow (little vitamin A) and orange (high vitamin A). Most varieties are chosen for sweetness, though Dr. Martin has developed non-sweet varieties which people that do not care for sweet potatoes may enjoy. [Ed: this was the case with me.] Texture

ranges from dry (least preferred) to intermediate (often preferred) and moist (common in orange roots). Most plants are running (vining), a few are bunch varieties.

For practical purposes, in the tropics sweet potatoes are produced from cuttings of existing vines. (Only in the temperate zone is it necessary to conserve storage roots during the winter and stimulate them to grow in the spring as a source of sprouts for planting.) Where sweet potatoes are not grown year round, special plantings will have to be made as sources of cuttings, in which case it may be possible to obtain as many as 30 cuttings per plant. Usually best results are obtained by planting cuttings at an angle with about 2/3 of the cutting below the soil.

Cuttings should be 12-18 inches long. Shorter cuttings can be used if the distance between nodes is not excessive. The vines should be vigorous but not too soft and succulent. Old

thickened, diseased, and leafless cuttings should be avoided. It is not necessary to remove any leaves from the cuttings. Cuttings should be gathered together in convenient-sized bundles, tied, or wrapped in burlap. These bundles should be held 1-3 days in a shady, protected area and maintained moist. This will stimulate root production, and even though the initial roots may be broken on transplanting the cutting will be more ready to establish itself if allowed to pre-root as described. If weevils are a problem, immerse cuttings for 5 minutes in a drum containing 0.1% carbofuran. Use gloves. Plant within 24 hours. This treatment eliminates weevils within the cuttings.

The area selected for planting should be as far from previous sweet potato plantings and its morning glory relatives as possible. One foot (30cm) between plants in a row is a minimum. Individual plants will yield more if given up to 1 square yard (meter) of space, but many roots will be



excessively large. These large roots are edible but likely to be irregular in shape and unsightly. The layout of rows or beds will depend on the machinery or methods used for soil preparation.

Newly planted cuttings need watering frequently for 1-3 weeks. Once new growth begins water only when visible wilting is seen. Very little water will be necessary the fourth and fifth months. Remember, too much foliage means poor or late storage-root growth. Excessive foliage with poor yields is usually due to too heavy fertilization, especially with nitrogen. Any method that destroys part of the foliage tends to decrease this problem. Try feeding a portion of the vines to animals. [Dr. Martin told me of seeing men drag thorn bushes through the patch to tear up some of the leaves.]

There is no perfect time for harvests. Early harvest results in less yield, smaller roots, less insect damage, less cracking,

milder flavors, and poor storeability. Late harvest results in the reverse. If insects are not a problem, partial or periodic harvest from 3 to 8 months may be possible. Cut away the vines before harvest. These can be fed to animals. As soon as possible after digging, remove the sweet potatoes from the sun. The roots should be sorted. Very small roots can be fed to animals. Damaged roots can be used immediately or processed as previously described. Sound roots can be stored at cool temperatures (minimum 55 F, 13 C) for 2-8 weeks. Rot of roots in storage is reduced by curing at high (80-90%) humidity and high (90-95 F) temperature for 4-5 days. Cured roots can be stored at the recommended temperature for up to 1 year.

**SWEET POTATO CULTIVARS AVAILABLE.** We grew and compared several of Dr. Frank Martin's sweet potatoes, both the non-sweet and sweet varieties. We selected six superior cultivars based on a combination of traits, including:

uniqueness (not available elsewhere), yield, sugar content, ease of processing, texture, shape, color, time to maturity and reliable yield. These are the ones we will distribute from now on.

Cuttings are typically available July through October. Please send \$5 to help with postage and handling if that is possible. Since the danger of introducing a new disease or insect is so much greater with fresh plant tissue than with seeds, we will only send them after receiving a government plant import permit from you. Be sure to designate which varieties you would like. If a phytosanitary certificate (certified disease and insect free) is required by the permit, enclose an additional \$20 per order. If you use a USA address, check with us first. Many states in the US have restrictions on shipping sweet potatoes into the state. It is much better to pick up the cuttings on a visit to ECHO en route to your country, as cuttings may not survive very well in shipping.

Varieties selected were: "Topaz" (orange and sweet, closest to typical US varieties but 50% higher yielding for us, somewhat less uniform, some drought resistance; "Ivoire" (non-sweet, "Irish" potato substitute, very dry if harvested after 12 weeks); "Viola" (purple skin, white flesh, sweet, good flavor, has done well everywhere); "Colorette" (low in sweetness, high yielding, light orange flesh, light purple outside); "Suabor" (large, sweet, smooth, early maturing, yellow when cooked); and "Toquecita" (good yield, white skin and flesh, sweet, large tuber, but highly lobed, excellent for processing).

SWEET POTATO COOKBOOK. We have appreciated contributions from Dr. Frank Martin on many topics over the years. His main professional interest, however, is the breeding of sweet potatoes. When his technical expertise and personal interest in cooking was teamed with the skills of writer and agriculturalist Ruth Rubert and amateur gourmet cook (and professional engineer) Jos Herrera, this unique and valuable

cookbook resulted.

Frank's personal acquaintance with scientists and sweet potato enthusiasts from many countries has made him aware of many delightful recipes that make this book an outstanding addition to the kitchen library. But it is his familiarity with the different kinds of sweet potatoes that makes the book especially unique. The type of sweet potato influences its cooking. Each type is better for some purposes than for others. The cookbook includes recipes designed to take advantage of these different types: dessert, tropical, white staple or orange staple types.

Dessert type sweet potatoes are very sweet, usually moist in the mouth, and almost always orange. On cooking in any manner, sweetness increases markedly. The flavor may seem carrot-like or even oily to some people. Tropical type sweet potatoes are less sweet, often dry in the mouth, and white, cream or yellow. Flavor is highly variable. These are the kinds

of sweet potatoes most often found in the tropics, but a few are grown in the USA (Yellow Jersey, Rojoblanca and the Cuban boniatos of Florida). Cooking in any form increases sweetness. White staple "non-sweet" types were developed by Frank just before he retired. They are not sweet or are only very slightly sweet. Sweetness does not increase, or increases only slightly, upon cooking. They are often, but not necessarily, dry and need to be mashed to make them attractive to most palates. The flavor is usually neutral. They are white, whitish, cream, or pale yellow in color. Yellow staple type sweet potatoes is the orange-colored equivalent of the white staple type. They have a large amount of provitamin A and may taste like a carrot to some people.

Sweet potatoes are one of the world's most important food crops, surpassed only by wheat, rice, corn, Irish potato, and barley. Frank says they have the potential to be an even more important crop for peasant farmers (and the rest of us for that

matter). The key to increasing their usefulness may surprise you-get rid of the sweetness! "Irish" potatoes (which really came from South America) are a temperate crop and poorly adapted to the hot, humid tropics. Yet their taste and cooking versatility are appreciated around the world. Dr. Martin believes that "bland" sweet potatoes, which could be used like Irish potatoes, could become a major part of tropical diets in a way more traditional varieties never could. These non-sweet or staple type sweet potatoes are almost a new crop. I have never cared much for sweet potatoes, but I very much enjoy the non-sweet varieties (with butter and chopped onion). Both taste and texture more similar to the potato, though still different.

Sweet potatoes are easy to grow, relatively free of pests, highly productive, and always good food. They produce in poor tropical soils without the benefit of fertilizers, tolerate drought once established, and thrive in tropical heat. Americans are

often surprised to learn that sweet potato leaves are a popular vegetable in many countries. When both leaves and tubers are used for food, sweet potatoes will probably produce more nutrition per acre than any other crop. This all adds up to one fantastic crop for small land-holders in the tropics and sub-tropics. The cost of the book from ECHO is \$6.00 plus postage.

LIVING SUPPORT POLES FOR YAMS (*Dioscorea* spp.). [From "The Garden to Kitchen Newsletter" quoting Mike Bengé with USAID.] This process is being used by farmers near the University of the Philippines at Los Baños. Fast-growing, nitrogen-fixing trees such as *Leucaena*, *Gliricidia*, or *Calliandra* are planted ahead of time to shade out grasses. Yams are planted near the base of the tree after weeds are controlled. When the tuber begins to form, the tree bark is removed about 40 cm from the ground. This causes leaves to drop, giving full sun, mulch, fertilizer and support for the vine and eventually provides firewood. One strong sucker is left from



the new tree growth below the girdled area to produce another tree.

Peter Afekoro in Nigeria writes that a lot of farmers are now using the growing branches of the moringa tree as a source of stake material for yam vines. The interesting aspect to him is that when you cut the young tree for the stake, it sends up 6-10 new trunks for use next year. [It tends to be weak, fast-rotting wood, however.] We discovered quite by accident here at ECHO that yams love to grow right up living moringa trees. The light shade does not seem to harm them at all, nor do the vines seem to harm the moringa tree.

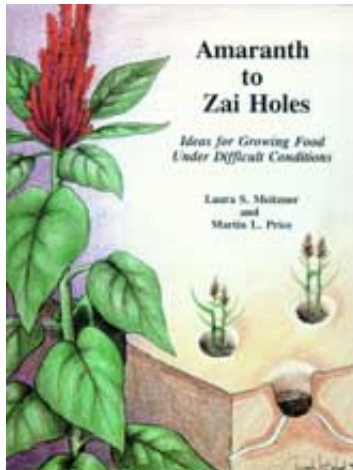
The April 1990 issue of Agroforestry Today reports that farmers in Kenya's eastern highlands are using a local tree, *Commiphora zimmermannii*, (local names: mutunguka, mururi, kitungati) as stakes for both yam and passion fruit. It is drought tolerant, easily rooted from green stakes, slow

growing with few lateral roots that might compete with crops, has no large dense canopy to shade crops, and thrives under frequent pollarding. (Pollarding is cutting back severely to a certain height, then letting new branches form near the top.) "Heavy vines would kill many trees, but Kenyan farmers claim that the mururi, once established, is permanent." A picture shows a farmer with yams on living stakes that appear to be about head high and were planted 20 years ago. "Few species could survive under these dense and heavy vines." It is also popular as living fences and is legally recognized as boundary markers because it is so permanent. If any of our Kenyan readers can supply ECHO with enough seed (if it produces seed) to make up 30 or so packets to offer to our network in other countries, please send details including postage costs and any insights you may have about growing the tree.



[Home](#)-immediately access 800+ free online publications.  
[Download](#) CD3WD (680 Megabytes) and distribute it to the 3rd World. CD3WD is a 3rd World Development private-sector initiative, mastered by Software Developer [Alex Weir](#) and hosted by [GNUveau Networks](#) (From globally distributed organizations, to supercomputers, to a small home server, if it's Linux, we know it.)[ar](#).[cn](#).[de](#).[en](#).[es](#).[fr](#).[id](#).[it](#).[ph](#).[po](#).[ru](#).[sw](#)

---



- 📖 Amaranth to Zai Holes, Ideas for Growing Food under Difficult Conditions (ECHO, 1996, 397 p.)
- ➔ ☐ 4: Multipurpose trees
  - 📄 (introduction...)
  - 📄 Trees in agricultural systems
  - 📄 Multipurpose trees
  - 📄 Fruit and nut species
  - 📄 Working with trees

## **Amaranth to Zai Holes, Ideas for Growing Food under Difficult Conditions (ECHO, 1996, 397 p.)**

### **4: Multipurpose trees**

All trees are multipurpose. They bring subsoil nutrients to the surface, provide shade, and slow erosion. Many trees provide fodder, living fenceposts, fruit and other edible parts, shade, insecticides, and wood; they all have some role in soil stabilization and offer quality- of-life benefits like beauty and a shelter for informal gatherings. Working with trees is an important investment which can be significant to the future of your community. Developing agroforestry systems, tree nurseries, and fruit and nut tree species is most appropriate for those with a long-term commitment in an area. Learning the valued qualities of the trees already present in and native to your area is a good starting point. Ask about the best local

woods for fuel, construction, musical instruments, stakes, and other uses; ask children about the season and flavor of native fruits. Observe closely how various species are propagated, harvested, and protected. This chapter gives ideas and information on the many uses of trees in agricultural systems, various species, and working with trees.

## **Trees in agricultural systems**

ICRAF is the International Centre for Research in Agroforestry, headquartered at United Nations Avenue, P.O. Box 30677, Nairobi, KENYA. Their research is directed at mitigating tropical deforestation, land depletion, and rural poverty through improved agroforestry systems. ICRAF (1992 Annual Report) defines agroforestry as "land-use systems and practices where woody perennials are deliberately integrated with crops and/or animals on the same land management unit. The integration can be either in spatial mixture or in temporal

sequence. There are normally both ecological and economic interactions" between the trees and other components of an agroforestry system. ICRAF focuses on sustainable technologies for small landholders in the humid to semi-arid zones of the tropics. They have a wide variety of excellent publications and are a good contact for questions related to the use of various tree species in agricultural systems.

"PRINCIPLES OF AGROFORESTRY" (10 pp.) by Dr. Frank Martin and Scott Sherman is a basic introduction for those with little or no prior experience in this field. They define agroforestry as "the integration of trees, plants, and animals in conservative, long-term, productive systems." Agroforestry is seen as an approach to agriculture, not a single finished technology. Benefits for the farmer include: food, feed, fuel, fiber, soil conservation and renewed soil fertility. Tables include: trees with edible products; principle agroforestry species; successful examples from various locations; successful

examples of integrating trees and crops; and seed suppliers. The tables are followed by a section of definitions, a bibliography, and two pages of related resources and organizations. Available from ECHO for \$3; free to development workers.

A TOOL KIT FOR FOLKS INVOLVED IN AGROFORESTRY. IIRR's Agroforestry Technology Information Kit is just the kind of practical resource we are always looking for. The kit is a collection of practical, well-illustrated summary sheets on various technologies related to agroforestry and sustainable agriculture in the tropics. It was originally designed for use by social forestry officers and technicians in the Philippines. Some of the common names of plants will not be familiar to most, but the information contained in the kit would be of interest to a wide range of development workers.

Topics are divided into the following basic categories (followed

by a sampling of topics): Soil and Water Conservation Technologies and Agroforestry Systems (SALT-1, alley cropping, in-row tillage, A-frame use and construction, vegetative barriers, controlling cogon [grass], etc.); Annual Cropping System (cover crop selection, upland rice cultivation, root crops, cultural pest management, etc.); Seeds and Plant Propagation (seed collection, processing, testing, storage, and pre-germination treatments; tree nursery establishment and management; plant propagation, transplanting, etc.); Trees and Their Management (SALT-3, boundary plantings and shelter belts, pruning, fruit trees for harsh environments, growing bamboos, bank stabilization, species comparisons, etc.); Livestock Production (SALT-2, forced feeding, housing, plant-based medications, intensive feed gardens); and Home-Lot Technologies (medicinal plants, bio-intensive gardening with agroforestry, mini-ponds for dry areas, fertilizer from farm wastes, etc.). There is probably nothing in the kit that ECHO does not already have in our resource center. However,



to have it all summarized in a highly pictorial manner is very helpful. Basically, it is a collection of simple, proven, basic, sustainable technologies with potential for further exploitation by resource- poor farmers. Kits are available in booklet form for US\$27 from IIRR, 475 Riverside Drive, Room 1035, New York, NY 10115, USA; phone: 212/870-2992; fax 212/870-2981; e-mail iirr@cce.cornell.edu. Kits are also available (US\$8/P200 plus postage, very reasonable in Asia) from the IIRR headquarters in the Philippines at IIRR Bookstore, Silang, Cavite 4118, PHILIPPINES; phone 63-969-9451; fax 63-969-9937.

AGROFORESTRY TODAY is published by ICRAF, a non-profit international research body governed by a board with equal representation from developed and developing countries. ICRAF's mandate is to "initiate, stimulate and support research leading to more sustainable and productive land use in developing countries through integration of trees in land-use

systems." The articles were more practical and applied than their research orientation had led me to expect. Articles in the one issue included "Agroforestry: a very social science," "Readings in social agroforestry" [a bibliography], "The great eucalyptus debate," "The apple ring Acacia", and an article on beekeeping and forestry. I will quote from the latter.

" 'The secret of extending the period when flowers are available to bees,' says Dr. Michel Baumer [ICRAF staff], 'is paradoxical.' Best results are achieved by planting trees which are actually somewhat ill-suited to their environment. 'If you plant trees that are well-suited to an area, they'll flower when all the other trees flower,' he says. 'But those which are not at their ecological optimum, which are slightly marginal to local conditions, will often produce their flowers at a different moment than their neighbors. Some trees under these conditions even react by producing more flowers than normal.

" 'For example, *Eucalyptus gomphocephala* gives better results in some places in North Africa than on its native sandy plains of southwestern Australia. There are tens of thousands of flowers on an adult eucalyptus .... Even one tree represents a considerable source of nourishment for a bee colony.' ...A tree of great potential for dryland beekeepers is the apple ring acacia, *Faidherbia albida*, also called *Acacia albida*. For beekeepers in the Sahel-Sudan area it has the advantage of producing flowers at the end of the rains (most trees in this area flower before or during the rainy season) and it is the main source of nectar and pollen, if not the only one, during two or three critical months.'"

Subscriptions are US\$40 for individuals. Those unable to pay may state their case for a free subscription. Order from ICRAF, United Nations Avenue, Gigiri, P.O. Box 30677, Nairobi, KENYA; phone (254 2) 521450; fax (254 2) 521001; e-mail ICRAF@CGNET.COM. It is also available in French and

## Chinese.

"ALTERNATIVES TO SLASH-AND-BURN" BULLETIN. ICRAF is coordinating a "Global Initiative for Alternatives to Slash-and-Burn Agriculture." Publication of this quarterly bulletin is part of that effort. It highlights ASB activities around the world, including research at three benchmark sites in Cameroon, Brazil and Indonesia and related training programs. Add your name to the mailing list by writing ASB Update; ICRAF; P.O. Box 30677; Nairobi, KENYA; fax (254 2) 521 318; e-mail D.BANDY@CGNET.COM.

AGROFORESTRY STUDY TOURS. (Abstracted from Agroforestry Today.) Technical and Study Tours, Ltd. organizes study tours in Kenya focusing on agroforestry, agriculture, forestry and the environment, as well as wildlife safaris. Participants can become acquainted with more than a dozen successful agroforestry projects, meet with ICRAF staff, make use of

ICRAF facilities, and visit their field station at Machakos. Contact Technical and Study Tours, P.O. Box 50982, Nairobi, KENYA; phone (254-2) 791227/780461; fax (254-2) 780461.

RESTORATION FORESTRY: AN INTERNATIONAL GUIDE TO SUSTAINABLE FORESTRY PRACTICES edited by Michael Pilarski, 1994, 528 pp. It is difficult to put together a resource this comprehensive! This well-researched and -indexed reference manual distills 15 years of dedicated experience in this field. Over 50 authors contributed, and it serves as a sourcebook for information on over 2400 forestry books, articles, organizations, periodicals, and individuals. It is an excellent and international overview of sustainable forestry. Model forestry projects are described, university degrees in forestry are mentioned, and complete contact information is given for most entries. Available for US\$26.95 plus postage (\$4.05 in USA; \$6.75 overseas surface; \$21 overseas airmail) from Friends of the Trees, P.O. Box 4469, Bellingham, WA

98227, USA; tel/fax 509/485-2705.

A NETWORKING NEWSLETTER FOR AFRICA. Since 1990 the Methodist Church Division of Social Responsibility and the Methodist Relief and Development Fund have produced a networking newsletter called Africa Link. It is part of their Africa Water and Agroforestry Program, and it is published twice a year in English and French. Typical contents include brief news items provided by members telling what they are doing, conferences or workshops they have held or plan to hold, and references to resources available in Africa. Each recent issue has included a complete reprint of an article selected from another publication which the editor believes would be of interest to members. An item we gleaned from the last issue (how to keep rats from young oil palm trees) appears in Chapter 8. African development workers can write them at Methodist Relief and Development Fund; Division of Social Responsibility; 1 Central Buildings; Westminster,

London SW1H 9NH, UK; phone 071 222 8010; fax 071 799 2153.

DIRECTORY OF INTERNATIONAL TRAINING AND EDUCATIONAL OPPORTUNITIES IN AGROFORESTRY. Several have asked us where you could go for a degree in agroforestry, a question that we have not found easy to answer. So we welcome publication of this 78-page book by the United States Department of Agriculture. "One of the most severe limitations to the successful adoption of agroforestry land-use systems has been the dearth of personnel with the knowledge and skills to integrate the various disciplines required in researching, planning and managing agroforestry interventions." The book covers universities and other institutions, degrees and short courses, in the USA and overseas. This 1993 book is free from Robin Maille, USDA Forest Service, International Forestry, Franklin Ct. Building #5500W, P.O. Box 96538, Washington, DC 20090-6538.

ICRAF/Nairobi is now preparing and publishing this directory, and they are working on a 1995 edition, as new programs and courses are coming on line all the time. To order a copy or to let them know about a course your institution offers, write ICRAF at their address above.

SHADE FOR INCREASED SOIL FERTILITY UNDER TREES. A report by John Wilson in the January-March 1990 issue of Agroforestry Today suggests that shade may be one of the leading factors for increased soil fertility in agroforestry systems. We know that agroforestry systems can increase soil fertility, presumably by pulling nutrients from deeper in the soil or by nitrogen fixation from leguminous trees. There are frequent reports of improved grass growth under tree canopies, but the grasses grown under the canopies may be species which prefer shade over full sun. For example, an Australian study reported "a 250% higher yield of *Panicum maximum* under the canopy of a leguminous tree, *Albizia*



lebbeck, than outside the canopy in full sun." Dr. Wilson's work found a 30% increase in growth of the grass *Paspalum notatum* under 50% shade of the non-leguminous *Eucalyptus grandis* and a 70% increase in total nitrogen in the grass compared with grass in full sun.

As evidence for his theory, Dr. Wilson cites an experiment he performed in an open pasture field of *Panicum maximum* where shade was the only factor. Areas were covered with shade cloth so that the sunlight was 50% of its normal intensity. The total herbage yield in shaded areas increased 43%, nitrogen in the leaves increased 43%, and the soil nitrogen increased 106%. He attributes this to lowered soil temperatures (maximum centigrade temperatures of 30-36 under shade versus 45-50 in full sun). The lower soil temperature promotes microbial activity and soil mineralization. "This influence is important in areas where the soil nitrogen level is a limitation to crop or pasture growth."

**NEMATODES IN AGROFORESTRY.** Nematodes are tiny "wire worms" that abound in the soil. The root- knot nematode, *Meloidogyne incognita*, is one of the most infamous, both for its devastating effect on crops and the ease with which its presence can be identified. It causes knots to form on the roots, in some cases making roots look something like a string of beads. Other kinds of nematodes also cause major crop losses, but require a nematologist to identify them.

The increasing use of agroforestry systems in which trees and shrubs are permanently grown in close association with annual crops raises an interesting question. How do these associations affect nematode damage, especially if the trees are themselves hosts for nematode survival and population build-up? This question is addressed in an article in *Agroforestry Today* by Mia D'Hondt-Defrancq (April-June 1993, pp. 5-9), from which the following is abstracted.

"Two types of interaction between trees and crops affect nematode populations. Direct interactions take place where the nematode population is directly influenced by the introduction of a species of plant new to the area or a new species of nematode." Indirect influences occur when the nematode population is altered by the local environment.

Direct Influences. Some species of trees and shrubs actually reduce the number of certain species of nematodes. This might be due to a chemical that is exuded which kills nematodes. In other cases the tree or shrub acts as a trap-host (it attracts nematodes but prevents their reproduction).

"In Nigeria, for example, the deliberate planting of *Leucaena leucocephala* in a fallow period dramatically reduced parasitic nematode populations in the soil. When the fallow was converted to *leucaena* alley-cropped with maize, the population of parasitic spiral and root lesion nematodes

remained low. In West Africa, *Sesbania rostrata* acts as a trap host for the *Hirshmaniella* species of nematode that are prevalent in flooded areas where rice is grown."

"In cases where trees and shrubs are suitable hosts for harmful nematodes ... [the damage] may increase drastically. This is because the host will not only allow continuous build-up of the nematode population but will become a very efficient reservoir from which attacks can be made [on future crops]." For example, there were many more nematodes within 2.5 meters of a *Sesbania* hedgerow in the Rwandan highlands than there were 5 meters from the row. In Malawi studies suggest that *Acacia*, *Leucaena* and *Sesbania* species can act as good hosts for root-knot nematodes. Presumably crops susceptible to this nematode will be more seriously attacked when grown in alleys with these trees. "Similar problems can be expected if *Tamarindus indica* or certain species of *Acacia*, *Albizia* and *Casuarina* are planted where the burrowing nematode is a

threat to crops such as banana or vegetables."

Indirect Influences. Trees can reduce nematode problems by indirect interactions. For example, many crop plants have some natural resistance to nematode attack, but this is reduced by high air and soil temperatures (both of which are reduced by shade). Trees and shrubs can also reduce soil erosion and hence prevent the spread of nematodes that are attached to soil particles. To the extent that trees reduce growth of weeds that harbor nematodes, crop losses may be reduced. If benefits of the trees cause crops to be more vigorous, this in itself can reduce nematode injury. "There is also evidence that leachates from the litter of certain trees and shrubs [Ed: water that has soaked through the litter] have nematicidal properties, e.g. *Azadirachta indica* (neem), *Ricinus communis* (castor bean) and *Leucaena leucocephala*."

Indirect interactions can be negative. Plowing reduces

nematode density. Reduced cultivation in an alley crop system can thus enhance nematode populations.

I have often wondered if knots caused by nematodes might not sometimes be confused with galls caused by nitrogen-fixing rhizobia. How can you tell them apart? "The nitrogen-fixing galls are readily identified because they are easily rubbed off from the roots and are often pink-red inside."

Many leguminous trees are also good hosts for nematodes. Nematode infection may reduce rhizobial colonization and, hence, nitrogen fixation.

"The following trees have been found to be resistant to the widespread *Meloidogyne incognita* (root-knot nematode):  
Acacia senegal, Acacia tumida, Anacardium occidentale, Azadirachta indica, Cassia obtusifolia, Cupressus sempervirens, Eucalyptus camaldulensis, Leucaena

leucocephala (found resistant in most countries), Sesbania tetraptera and varieties of Sesbania macrocarpa." The author did not provide a list of trees that definitely are harmed by nematodes. He did mention that Sesbania sesban failed in east Africa due to nematodes. Sesbania grandiflora is badly damaged by them at ECHO.

ALLEY CROPPING TO SUSTAIN YIELDS. (By Daniel Sonke, ECHO staff.) Alley cropping is an agroforestry technique which has been widely promoted in agriculture development programs throughout the tropics. Many studies report increased harvests in alley crops versus control plots without trees. However, a report from ICRAF in Kenya suggests that alley cropping has been too widely promoted in areas for which it is not suited. The ICRAF report states that alley cropping should not be practiced in dry climates with acidic soils or in areas of low fertility. In some instances the competition between crop and tree roots negates the expected

benefits of alley cropping. In others, yield increases were over-estimated because of procedural mistakes.

We contacted Dr. P.K. Nair at the University of Florida Department of Forestry for his perspective. Dr. Nair is a founding scientist of ICRAF, where he worked as a principal scientist for about 10 years. That interview is found later in this article, but first we will review the basics of alley cropping.

**A BRIEF OVERVIEW OF ALLEY CROPPING.** Alley cropping (AC) is the practice of growing food crops in alleys between hedgerows of trees or shrubs which are regularly "coppiced," or severely pruned. Sometimes the prunings of these trees are placed on the soil as a mulch around the food crops. As this mulch decomposes, its nutrients become available to the crops. Trees with roots which grow deeper than those of typical crops are used to bring nutrients up from the subsoil. Nitrogen-fixing trees are often used to maintain an input of



nitrogen into the cropping system. In this way, soil fertility is maintained or improved despite the removal of nutrients in the crop harvest. Typically an AC system consists of trees planted 20-50 cm apart in straight rows which are 4 to 6 m apart (rows may follow the contour if on a slope). The specific width of alleys depends on many factors, including average rainfall and the crops grown.

A version of alley cropping called the SALT technique (Sloping Agricultural Land Technology) was designed to control erosion (see Chapter 5 on Farming Systems). In SALT, trees are planted only a few cm apart in double rows (rows 50 cm apart). The double rows, which follow the contour, reduce the chance of an opening through which water could flow. As water passes through the double hedgerow, it is slowed down and much of the suspended soil is dropped, eventually forming a terrace of sorts. Crops are grown in alleys between the double rows. The hedgerows in alley-cropped systems provide

other benefits, including fodder and firewood, though some uses compete with their use as mulch and green manure. One report from an African region with limited trees states that farmers highly prized AC because they could grow more stakes for their yam gardens. ECHO used *Moringa oleifera* for its demonstration alley because leaves can be used for human food or animal feed.

Periodically the hedgerows must be pruned. For use as forage or mulch, a general guideline is to cut the trees by the time they reach 3 m in height or the stem diameter is more than 1 cm. The trees should be cut to 1 m or less. For some crops research has been done to determine whether timing of pruning is important for optimum nutrient availability. Delays in pruning may result in a "woody" mulch which does not decompose adequately. Obviously, AC is a labor-intensive venture not suited to farms with a labor shortage.

Some commonly recommended tree species are *Leucaena* spp., *Calliandra calothyrsus*, *Gliricidia sepium*, *Senna siamea*, *Sesbania sesban*, *Grevillea robusta*, and *Acacia* spp. Sometimes one may find that a native species is better adapted to local conditions and pests. Some general characteristics of a useful species are: -can be easily established -is fast-growing, producing much biomass -is deep-rooted, without many shallow, lateral roots -sends out new growth rapidly after repeated severe prunings -provides useful by-products (firewood, fodder, stakes) -has high protein (nitrogen) content in the foliage -has a compact canopy to prevent crop shading.

## INTERVIEW WITH DR. NAIR.

Q. What do you think of the ICRAF report on AC?

A. The report has been blown out of proportion in some journals. The limitations cited are not new revelations. We

have been saying from the beginning that AC is not suited to areas with limited water supply. In more humid zones it works beautifully well. In Kenya, for example, AC works very well in the humid regions, but very poorly in the drier regions. Unfortunately, too much eagerness by some people has caused it to be established without regard to its limitations.

Q. For what environments do you recommend AC?

A. Areas with poor soils and plenty of available moisture, where fertilizer is limited, and/or subsistence level agriculture is used. AC is effective on gentle slopes for preventing soil erosion; Haiti has working examples of this. I should caution that a plentiful low-cost labor supply is very necessary as well.

Q. What about the ICRAF recommendation against AC on acidic soils?

A. I have seen successful examples on acidic soils in high rainfall areas (which is where acidic soils often occur) when

appropriate tree species are used.

Q. What characteristics would you look for in a useful tree species?

A. High biomass production and nitrogen-fixation are desirable. The tree shape must not produce excessive shade to the crop. Generally species with small leaves or leaflets rather than broad leaves are used because of more rapid decomposition. Decomposition rate can be important; in some situations very rapid decomposition may result in the nutrients becoming unavailable to the crop. Where organic matter is lacking in the soil, slower decomposition may be desirable to improve soil. Leaves with high lignin or tannin may decompose too slowly. Each situation is different.

The trees chosen should not harbor pests of the crops, including birds for some crops and regions. Nor should the trees themselves be susceptible to pests. In Asia psyllids have

destroyed many agroforestry projects using leucaena. Diversifying the species used in a region lowers the risk of losses to insects or diseases. Deep-rooting species are important; shallow-rooting species compete with the crop.

Q. Can the severe pruning of a tree alter its rooting pattern, causing a deep-rooting tree species to produce shallow roots which might compete with crops?

A. This is an area in which we are presently conducting research. I do not want to make a claim without concluding the research. [Ed: We hope to report on this when research is available.]

Q. Can you make a general recommendation on how wide the alleys should be?

A. Alley width depends on the crop needs, available moisture, and the amount of mulch desired. Much research has been

done using different alley widths. I encourage people to consult the research applicable to their situation. Keep in mind that more narrow alleys means more tree area and less crop area. The increased tree growth produces more mulch which should increase harvests. Finding the optimum balance between mulch production and crop area is the goal.

Q. Is AC self-sustaining in the long term?

A. As in any system, occasional inputs of nutrients result in longer-term sustainability. AC is designed for areas where fertilizers are limited, but over time even limited inputs will be beneficial. It is also important to realize that removing biomass from the system in the form of firewood or animal fodder makes it less sustainable over time. Although this produces benefits to the farmer, it requires more inputs to compensate. In Haiti the theft of firewood from hedgerows frustrates farmers' efforts to be sustainable. [End of interview.]

The ICRAF report criticized that some alley crop research stations have produced faulty crop yield data due to improper procedure. At two sites mulch was imported into the system to produce better mulch than the hedgerows actually produced. At another semi-arid site tree roots spread 15 m and actually grew into the plot which was supposed to be a no-tree control plot, which suffered reduced yields from root interference without the shade and mulch benefits of AC. One method suggested to correct this was to dig a trench around the AC system to prevent roots from influencing crops around it. Senna species are also being used in experiments, since their black roots can be easily distinguished from others. If you wish to do your own experiments on AC in your area, we encourage you to use similar methods to obtain good data. If you do have experience or data on AC successes or failures, ECHO would like to hear from you.

Mike Benge, USAID, Washington D.C., wrote in response to



our article on alley cropping. "Many of the alley cropping systems ran into trouble with root competition when started with cuttings. Cuttings develop extensive lateral root systems, not true tap roots; however, they may develop pseudo tap roots. This causes severe competition for both moisture and nutrients. Gliricidia is a case in point. IITA started the alleys with Gliricidia cuttings, but after a while discontinued because of competition. They began to plant seedlings instead, which did not develop the extensive lateral roots, and found that competition was greatly reduced.

"From my observations in the field, once a tap root is cut, often it will not regenerate. Rather it develops a more extensive lateral root system and pseudo tap roots, which never reach the depth of a true tap root. This is extremely important in water-stressed areas. I suspect that aerial pruning in root trainers may have a similar effect; however, I have seen no research to prove or disprove this assumption."

**FORESTRY CONSULTING ASSIGNMENTS.** Are you looking for some new challenges when your present assignment ends? William Helin, with the U.S. Dept. of Agriculture Forest Service, wrote us about a listing of potential consultants maintained by the International Skills Roster; International Forestry; USDA Forest Service; P.O. Box 96538; Washington, DC 20090-6538; USA; or contact Ej Caplan by phone 202/273-4695. The database, which has 3000 experts in forestry, natural resource subjects, and disaster management, is used when the U.S. Forest Service, Peace Corps, USAID, or other development agencies request the help of consultants.

The skills most frequently requested relate to small-scale village forestry, farm forestry, or social forestry projects. There is increasing demand for expertise in resource management, environmental assessment, and land use planning. Consultants are requested in agroforestry, economics, environmental education, sociology, training,

watershed management and wood energy. Other requests are for drylands forestry, nursery operations, plantation management, shelterbelts, soil conservation, and specialist skills related to these areas. Requests for long-term assignments of two years or more are almost always for persons with previous overseas experience, such as with the Peace Corps or PVOs. Most require either French or Spanish.

## **Multipurpose trees**

THE NITROGEN FIXING TREE ASSOCIATION (NFTA) became part of Winrock International's FACT Net (Forest, Farm, and Community Tree Network) in January 1996. The FACT net is a resource for information on both nitrogen-fixing and non-N-fixing multipurpose trees. They offer a technical advisory service for people with questions about the species, maintain worldwide seed source directories, and produce "FACT Sheets" (6/year) on various species and research reports, among other

publications. (In the past we have mentioned NFTA's tree seedbank that was an outstanding resource to development organizations. That service is no longer available.)

For membership information, contact FACT Net, Winrock International, 38 Winrock Drive, Morrilton, AR 72110-9537, USA; phone 501/727-5435; fax 501/727-5417; e-mail forestry@msmail.winrock.org. The forestry staff provides a "global extension service" and can answer your questions by mail, phone, fax, and the Internet. This network is one of your best resources for information on many tree species. Some publications are available in Spanish, French, Indonesian, and Chinese; be sure to ask. The full set of about 100 FACT sheets on various species costs US\$12 plus postage.

**MULTIPURPOSE TREES AND SHRUBS: Sources of Seeds and Inoculants** by Peter G. Von Carlowitz and published by ICRAF is helpful in locating seed sources of MPTs (multipurpose trees)

and shrubs. (Another book, *Cornucopia*, is a great sourcebook for hard-to-find food plants. See the chapter on Seeds and Germplasm.)

Chapter 1 is a 40-page table listing: species name, seed suppliers and quantities available, number of seeds/kg, typical germination rates, and seed pretreatments. Chapter 2 is a country-by-country listing of information on the suppliers mentioned in Chapter 1: address, phone, telex, cable and fax numbers, type of institution (governmental, commercial, research, etc.), documentation available, currencies accepted, and forms of payment.

Chapter 3 is divided into thirds: an overview of nitrogen-fixing bacteria and other beneficial micro-organisms, a table of host species and related information, and a listing of inoculant suppliers. Chapters 1-3 end with an annotated bibliography of related readings. Chapter 4 has tables to help match the right

tree or shrub with the right climate and use. The rest of the chapter is a comprehensive listing of species profiles from ICRAF's MPT database. Available (US\$25 plus US\$10 for surface mail; airmail rate supplied on request) from: Head of Information, ICRAF, P.O. Box 30677, Nairobi, KENYA.

HONEY-PRODUCING TREES SUITABLE FOR MULTIPLE USE. We phoned Dr. G. F. Townsend at the University of Guelph to answer a Peace Corps volunteer's question concerning the pros and cons of the African hive. Dr. Townsend is a leading authority on beekeeping in the tropics. He has been receiving ECHO Development Notes, so knows the kind of material we publish. When I asked if there were any things he would like to write up and share with our readers, he quickly volunteered the topic of this note. (I mention this as a hint for others, scientists or development workers. Have you learned something that can be shared with our readers?) The highlights of his notes follow. You can request the Technical

Note from ECHO which contains the entire article. We do not like to feature plants unless we can provide seed, but we have been unsuccessful in obtaining seed of this entire list of trees. Please let us know if you could provide some to us.

What better way is there to solve the firewood problem than by planting fast growing trees that will also produce food and fodder? Some of the most suitable trees for this purpose are also valuable honey-producing trees that have nitrogen-fixing properties which will support grasses. Many of these trees are very adaptable to dryland conditions where the problem is most acute. A large proportion of the honey produced in tropical areas comes from trees, in contrast to the temperate regions where it is produced mostly from forage crops.

The growing of trees could make a community almost self-sufficient. Some of these trees, such as Prosopis species will produce food for humans and fodder for livestock within 3-5

years from seed, even in arid regions. They can be thinned for firewood and will support growth of dryland grasses. The beekeeping businesses they can support not only provide a valuable energy food but local and foreign currency from sale of beeswax. Work in Kenya has shown that beekeeping in many cases doubled or tripled the family income with no requirement for land and very little investment. With suitable infrastructure, no investment was needed at all.

The following trees are the most suitable for this purpose. [For additional information consult the book Firewood Crops by the National Academy of Sciences; unfortunately it is currently out of print. If you need more detailed information on these species, write the FACT Net at the address above.]

## **HONEY-PRODUCING TREES SUITABLE FOR MULTIPLE USES**

<b>TREE</b>	<b>OTHER USES</b>
-------------	-------------------



TREE	OTHER USES
<b>A. Humid Areas</b>	
1. Calliandra calothyrsus	Firewood, animal fodder. Fast-growing.
2. Gliricidia sepium	Firewood, fencing, animal fodder.
3. Gmelina arborea	Firewood, timber.
4. Guazuma ulmifolia	Firewood, timber, animal fodder, edible fruit.
5. Mangroves: Avicennia nitida	Excellent charcoal.
Laguncularia racemosa	Resins, tannin, pulp.
6. Syzygium cumini	Firewood, shade.

## B. Tropical Highlands

1. Eucalyptus flobulus	Firewood, tools, poles, pulp.
2. Grevillea robusta	Firewood, cabinet wood, shade for coffee or tea.
3. Inga vera	Firewood, furniture, shade, food, seed pulp.

## C. Arid Regions

1. Acacia senegal	Charcoal, poles, implements, gum arabic, fodder, food: dried seeds.
2. Acacia tortilis	Firewood, fence posts, animal fodder. Fast growing.
3. Albizia lebbek	Firewood, furniture, animal fodder. Tolerates salt.
4. Albizia citriodora	Firewood, poles, railroad ties, citronella.
5. Eucalyptus	Firewood, excellent charcoal, termite...

5. Eucalyptus camaldulensis	Firewood, excellent charcoal, termite-resistant wood, pulp.
6. Eucalyptus citriodora	Firewood, posts, general construction, fodder, food: pods.
7. Pithecellobium dulce	Firewood, posts, general construction, fodder, food: pods.
8. Prosopis spp.	Firewood, fence posts, fodder: leaves & seeds, food: seeds, erosion control.
.. pallida	Fast growing, tolerates salt, arid conditions, up to 300 m.
.. juliflora	Tolerates very arid regions up to 1500 m. May be weedy.

(The table "Other Important Tropical Honey-Producing Plants" is included in the Technical Note.)

## TREES AND SHRUBS OF THE SAHEL: THEIR

CHARACTERISTICS AND USES, by Hans-Jurgen von Maydell, 1990. Someone in our network in Mali brought this book to our attention. This beautiful 525-page book is still relatively compact (15x21 cm) for ease of carrying with you into the field.

The most striking feature is the large number of color photographs. Color photos illustrate the entire tree as well as such closeups as bark, foliage, flowers, fruits and/or seeds. For each tree, one page is devoted to photos and one to a written summary of key points (scientific name, family, description, distribution, site requirements, uses and references). Often, presumably for more important trees, additional pages of pictures and text are given. Appendices give vernacular names (in Bambara, Djerma, French, Gourmanche, Haussa, More, Peulh, Serer, Tamachek and Wolof); seed weights, pictures of seeds and fruits; and a list of botanical terms in English, German and French.

Order from Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ); Dag-Hammarskjold-Weg 1-5; Postfach 5180; D-65726 Eschborn 1; GERMANY. If you write on official letterhead explaining how you would use it in your work with agricultural development in the Sahel, a free copy may be available. Those who do not qualify for a free copy can order from Margraf Verlag, P.O. Box 105, 97985 Weikersheim, GERMANY; fax 49-(0)7934- 8156; about US\$49 plus postage.

SPECIES SELECTION FOR DIFFERENT CLIMATES AND USES.  
The Nitrogen Fixing Tree Association sent us this helpful list.  
Species followed by (\*) have thorns.

Arid/Semi-arid Plants For Fuelwood/Charcoal.

Acacia acuminata, A. aneura, A. aulocacarpa, A. farnesiana (\*), A. nilotica (\*), Casuarina cunninghamiana, C. equisetifolia, Haematoxylon brasiletto (\*), Parkinsonia aculeata (\*), Prosopis pallida (\*). Ibid. for Animal Fodder.

*Acacia albida*, *A. acuminata*, *A. aulocacarpa*, *A. nilotica* (\*),  
*Cajanus cajan*. Ibid. for Green Manure. *Cajanus cajan*.

Humid Lowland/Midland (0-1000 m) for Fuelwood/Charcoal.  
*Acacia auriculiformis*, *A. mangium*, *Calliandra calothyrsus*,  
*Casuarina cunninghamiana*, *C. equisetifolia*, *Enterolobium*  
*cyclocarpum*, *Gliricidia sepium*, *Leucaena leucocephala*,  
*Mimosa scabrella*, *Samanea saman*. Ibid. for Fodder. *Acacia*  
*angustissima*, *Enterolobium cyclocarpum*, *Erythrina*  
*poepigiana*, *Gliricidia sepium*, *Leucaena leucocephala*,  
*Sesbania grandiflora*, *S. sesban*. Ibid. for Timber/Fuelwood.  
*Acacia confusa*, *A. mangium*, *Albizia falcataria*, *Dalbergia*  
*retusa*, *Enterolobium cyclocarpum*, *Leucaena leucocephala*,  
*Samanea saman*. Ibid. for Green Manure. *Acacia angustissima*,  
*Albizia falcataria*, *Calliandra calothyrsus*, *Erythrina*  
*poepigiana*, *Flemingia macrophylla*, *Gliricidia sepium*,  
*Leucaena leucocephala*, *Mimosa scabrella*, *Sesbania*  
*grandiflora*, *Sesbania sesban*.

Tropical Midland/Highlands for Fuelwood/Charcoal.

Acacia mearnsii, Alnus acuminata, A. rubra, Leucaena diversifolia. Ibid. for Fodder. Acacia angustissima, Chamaecytisus palmensis, Leucaena diversifolia. Ibid. for Timber/Fuelwood. Artocarpus fraxinifolius, Alnus acuminata, A. rubra, Leucaena diversifolia. Ibid. for Green Manure. Acacia angustissima, Leucaena diversifolia.

The Kenya Forestry Seed Centre seed catalog has the most complete listing we have seen. Nine pages of the catalog give "Climate Zones and Species Suitability" based on humidity/rainfall, altitude, and mean annual temperature. These charts provide an important guide before you purchase seeds; for example, there are relatively few species suitable for over 2400 m altitude, but these lists give you a place to start. (We were not able to contact them at their Nairobi or Kikuyu addresses, so ECHO can send you the listing.)

THE NEW FORESTS PROJECT provides packets of tree seeds, technical information, and training materials free of charge to groups interested in starting reforestation projects with fast-growing, nitrogen-fixing trees. Available for distribution are seeds of *Cajanus cajan* (pigeon pea), *Leucaena leucocephala*, *Gliricidia sepium*, *Robinia pseudoacacia* (black locust) and *Prosopis juliflora* (mesquite). Write The New Forests Project, 731 8th St. SE, Washington, DC 20003, USA; phone 202/547-3800; fax 202/546-4784. Include an environmental description of your area, including elevation, rainfall, temperatures, soil type, and the purpose of the tree planting.

"FODDER TREE LEGUMES: Multipurpose Species for Agriculture" is a six-week course (offered in Nov/Dec in 1996) in Queensland, Australia. Participants learn about the range and characteristics of fodder tree species available and evaluate roles in animal production and soil protection. Cost in 1996 is A\$12,000 (about US\$8760) plus airfare to and from



Brisbane. Write to Fodder Tree Legumes, Course Secretariat, Dept. of Agriculture, The University of Queensland, St. Lucia, Queensland 4072, AUSTRALIA; phone 61 7 365 2062; fax 61 7 365 1188.

### ACACIA ANGUSTISSIMA AND CALLIANDRA CALOTHYRSUS.

Lloyd Rowlands in Zaire wrote: "Another thing I am trying is *Acacia angustissima*. It out-performed 10 other species of trees from our NFTA trial. After 2 1/2 years it is 5 meters tall and about 6 cm thick! It is far better than *leucaena* in this area. I want to try incorporating it into an alley-cropping system. [Ed: In alley cropping, crops are planted in "alleys" between rows of trees that are planted a few inches apart and kept cut back to a few feet in height.] I have no other information on the species. Even NFTA, who sent the seed, has little information." (Neither does ECHO; please send us what you know.)

"The trial also included *Acacia auriculaformis*, *A. melanoxylon*, *A. mearnsii*, *Calliandra calothyrsus*, *Casuarina cunninghamiana*, *Chamaecytisus palmensis*, *Leucaena diversifolia*, *Mimosa scabrella* and *Sesbania sesban*. Due to drought, weeds and termites, only the first 5 species survived two years. After planting, the trees received no special treatment, as I was trying to do nothing that local farmers would not provide."

In a later letter, Lloyd wrote, "About 5 weeks ago a fire swept through the trees. Although all were killed above ground, *A. angustissima* are re-sprouting from the base and already average 55 cm high. Some are almost a meter tall. "This would seem to indicate that this species has good coppicing ability [i.e., ability to resprout from the base]. So they should be well suited to an alley cropping system.

"*Calliandra* is showing some signs of recovery with some

shoots about 10 cm tall. Some nearby *Leucaena leucocephala* trees also burned. These are showing very poor signs of recovery. I cut down one tree. The wood is very hard, difficult to whittle with my rather sharp knife. I expect it will make good firewood or charcoal."

ECHO received a few seeds from NFTA and some from the International Livestock Research Center in Ethiopia. Seeds must be scarified by placing in hot water in the morning and left there while it cools and perhaps most of the day. Seeds are available only to our overseas network.

Robert Brook at the Lowlands Agricultural Experiment Station, Papua New Guinea, wrote: "In a past EDN, Lloyd Rowlands shared his experience with *Acacia angustissima* in Zaire. Here in Papua New Guinea we have been testing this tree alongside other leguminous species.

"At both sea level and at 1650 meters (4900 feet) it outperformed all other species, including *Leucaena leucocephala* K8 (and other varieties of *leucaena*). At sea level it grew at an average rate of 35 cm per month and after 8 months had a stem diameter of 5 cm. At 1650 meters it grew in 22 months to 2.6 meters tall with a stem diameter of 4.3 cm. Both are well watered sites. I have also planted at 2200 m, but have no results yet.

"The Royal Botanic Garden, Kew, England passed on the following information about this species. It comes from Texas, Mexico and Central America and is found from sea level to 2600 m. It prefers open sites, but is adapted to a wide range of habitats. It has a tendency to be something of a weed (an important point).

"Concerning the 'weediness' of *A. angustissima*, at our 1650 meter site naturally sown seeds do not germinate for a year or

so, which indicates a dormant period. After this period seeds seem to germinate readily. It does not seem to set seed readily at sea level. For germination in the nursery, scarification (soaking in 90 degree C water for 30-60 seconds) is necessary. I have experienced no problems germinating it in a sawdust medium at sea level, but it does very poorly when sown directly in the field at low elevations; at higher altitudes it grows readily when field sown. Its fodder quality is reported from Australia to be poor, with low digestibility of nitrogen.

"*Calliandra houstoniana* is similar to the better known *C. calothyrsus*, but produces foliage even more profusely and naturally forms a more dense hedge. It looks like a good prospect for alley farming and erosion control barriers. *C. calothyrsus* is reported to have a high tannin content in the foliage, which makes it a problem for use as a fodder. I do not know if *C. houstoniana* has the same characteristics. It flowers profusely and butterflies love it, so it might be useful for bee

keeping. Its glossy green foliage and relatively compact form (2.5-3 meters at sea level) make it a good ornamental.

"Our work with these and numbers of other species continues at a wide range of sites, so readers may like to write to find our latest results." His address is Lowlands Agricultural Experiment Station; P.O. Keravat; East New Britain Province; PAPUA NEW GUINEA.

GLIRICIDIA SEPIUM. Gliricidia is a fast-growing leguminous tree for frost-free tropical regions with 450- 3500mm rainfall. It is used for fodder, living fences, green manure, contour plantings, fuelwood, etc. It is fairly termite resistant. This species is native to Central American and Mexico. See Chapter 8 on Plant Protection for information on using this tree to kill rats.

LEUCAENA LEUCOCEPHALA.



*Leucaena leucocephala* is a fast-growing, leguminous tree

"I want to plant *Leucaena*, but which type should I choose?"  
*Leucaena leucocephala* is a fast-growing, leguminous tree that nearly all of you have heard about. It has been used for reforestation, for firewood, and as a forage crop that can equal alfalfa in nutritional value. Researchers have given it much attention in recent years. We have compiled the following

recommendations from various sources in our files, especially from material provided by Dr. James Brewbaker, professor of horticulture and genetics at the University of Hawaii. There are three basic types of leucaena trees: Hawaiian, Salvador, and Peru. There are also crosses between these. You need to chose the type that best fills your needs. The Hawaiian type is short and bushy. Because its yield of wood and foliage is low compared to the other two types, this would probably be a poor choice. The Salvador type (Hawaiian giant) is tall and tree-like. The trees can grow 60 feet in height in 5 years. The best varieties of this type are K28 and K67. K67 is the best variety for projects that need high seed production. The Peru type is tall with extensive branching. The trees are good for forage; K6 is a good variety. An excellent forage-type leucaena is the Cunningham (K500) which was developed in Australia. It is a cross between the Salvador and Peru types.

Dr. Brewbaker has strongly recommended that we distribute



more than one variety. He says, "...this is a self-pollinated, pure-line species, and it is a long-lived tree. We want to avoid spreading one variety over very large areas." (We presume this is because there is less danger of total loss from an insect or disease outbreak if several varieties have been planted.) His particular recommendation is that we distribute K28, K67 and K500. ECHO has these types among others and will be happy to send you several small packets for trial. If you want larger quantities or different varieties, write to us requesting a list of leucaena suppliers. We have addresses for suppliers in Asia, Australia, North and South America. We can also send a practical, two-page write-up by Dr. Brewbaker on how to germinate, transplant, collect and store seeds, etc.

Varieties K4 and K743 (hybrid) are low in mimosine, a chemical present in leucaena which can be toxic to animals when eaten in large quantities. *Leucaena diversifolia* is better for higher altitudes (500-2000m) than *L. leucocephala*; ECHO

usually carries two varieties of this species.

See Chapter 8 on Plant Protection for information on the psyllid problems in Leucaena.

**EYE-CATCHING LEUCAENA.** Terry Waller wrote from Equatorial Guinea: "The velvet bean you sent before we were transferred to Bolivia was the most prolific and several church members were growing them in villages. The K8 variety of leucaena also grew great and we were able to introduce the concept of agroforestry. A recent letter from one of the farmers mentioned a surprising result: the aesthetic influence of agroforestry. He said that people from all over his neighborhood were coming by his garden (he lives in a very crowded slum area) and having pictures taken. Then they would get interested in the more practical aspects. Poor people like to feel good about their surroundings too."

THE MORINGA TREE, MORINGA OLEIFERA, IS CALLED MOTHER'S BEST FRIEND. That is one way they sometimes refer to this tree in the Philippines where the leaves of the malunggay, as they call it, are cooked and fed to babies. Other names for it include horseradish tree and drumstick tree (India) and benzolive (Haiti). Moringa is one of the most successful plants in ECHO's seedbank. Moringa tree leaves, pods, and roots are eaten; flowers are loved by bees; and seeds are powdered and used to purify water from murky rivers. I believe it is one of the most exciting and versatile plants that we have in our seedbank of tropical plants.

The leaflets can be stripped from the feathery, fern-like leaves and used in any spinach recipe. Small trees can be pulled up after a few months and the taproot ground, mixed with vinegar and salt and used in place of horseradish. Very young plants can be used as a tender vegetable. After about 8 months the tree begins to flower and continues year round.

The flowers can be eaten or used to make a tea. They are also good for beekeepers. The young pods can be cooked and have a taste reminiscent of asparagus. The green peas and surrounding white material can be removed from larger pods and cooked in various ways. Seeds from mature pods (which can be 2 feet long) can be browned in a skillet, mashed and placed in boiling water, which causes an excellent cooking or lubricating oil to float to the surface. The oil reportedly does not become rancid and was once sold as "ben oil." The wood is very, very soft, though the tree is a good living fencepost. It makes acceptable firewood but poor charcoal.

It is an extremely fast-growing tree. Roy Danforth in Zaire wrote, "The trees grow more rapidly than papaya, with one three month old tree reaching 8 feet. I never knew there would be such a tree." The tree in our organic garden grew to about 15 feet in 9 months, and had been cut back twice to make it branch out more. It is well to prune trees frequently

when they are young or they will become lanky and difficult to harvest. Where people begin breaking off tender tips to cook when trees are about 4 or 5 feet tall, the trees become bushier.

The folks to whom we have sent the tree in Africa have been pleased at its resistance to dry weather. Rob Van Os rated its growth, yield and potential as exceptional and added that it "can be planted after the other crops, even near the end of the rains." He has introduced it into several villages already. The first plants grew so well for Gary Shepherd in Nepal that he had us arrange for sending him 1,000 of the large seeds. He reports that at five months one was 12 feet tall and most were 6 feet.

There is more good news. The edible parts are exceptionally nutritious! Frank Martin says in *Survival and Subsistence in the Tropics* that "among the leafy vegetables, one stands out

as particularly good, the horseradish tree. The leaves are outstanding as a source of vitamin A and, when raw, vitamin C. They are a good source of B vitamins and among the best plant sources of minerals. The calcium content is very high for a plant. Phosphorous is low, as it should be. The content of iron is very good (it is reportedly prescribed for anemia in the Philippines). They are an excellent source of protein and a very low source of fat and carbohydrates. Thus the leaves are one of the best plant foods that can be found." In his Edible Leaves of the Tropics he adds that the leaves are incomparable as a source of the sulfur-containing amino acids methionine and cystine, which are often in short supply.

It responds well to mulch, water and fertilizer. It is set back when our water table stays for long at an inch or two below the surface. We planted one right in the middle of our vegetable garden for its light shade. The branches are much too brittle to support someone climbing the tree. It is not

harmd by frost, but can be killed to the ground by freezes. It quickly sends out new growth from the trunk when cut, or from the ground when frozen. Living fences can be continually cut back to a few feet.

CULTIVATION. I quote Alicia Ray, who wrote a booklet on the benzolive in Haiti some time ago. "It seems to thrive in impossible places-even near the sea, in bad soil and dry areas. Seeds sprout readily in one or two weeks. Alternatively one can plant a branch and within a week or two it will have established itself. It is often cut back year after year in fence rows and is not killed. Because of this, in order to keep an abundant supply of leaves, flowers and pods within easy reach, "topping out" is useful. At least once a year one can cut the tree off 3 or 4 feet above the ground. It will readily sprout again and all the valuable products will remain within safe, easy reach."

Scott Josiah writes that the Pan American Development Foundation in Haiti planted many kilometers of moringa as a living hedgerow on the contour of steep slopes, with mixed results. "In some cases, the growth has been excellent, nearly comparable to that of *Leucaena leucocephala*. However, *M. oleifera* has generally been a moderate performer, and seems rather sensitive to droughty sites and/or limited rainfall."

Beth Mayhood with Grace Mountain Mission wanted to establish a model vegetable garden on a small piece of land. "It was windswept and sunbaked with no natural barriers or trees in the area. Soils were poor and very alkaline. The salt content was also high. We started in January to prepare large quantities of compost. In April holes were dug in the poor soil and filled with compost. Benzolive trees planted in seedbeds germinated in 3-4 days. In 9 weeks they were transplanted in between the garden beds, around the edge of the 200 x 250 ft area and in a double row about 5 ft apart in the middle. The



trees protected against the prevailing winds." I saw slides of this spot later. It was impressive. The light shade of the tree is a considerable help to most vegetables.

I cannot emphasize enough how important it is to use pruning of some sort. If left to itself the tree becomes quite tall and lanky. This method of cutting it back to 4 feet each year sounds good. One method I tried with some success was to cut each branch back a foot after it had grown 2 feet until it was a multibranching shrub. Alternatively, normal harvesting can have the same effect if begun while the tree is young. Beth Mayhood wrote, "We liked them so much we began picking the growing tips to boil as a spinach several times a week. This picking of the growing tips caused the tree to branch. Our constantly pruned trees became thick-limbed and many-branched."

I am told that when grown for its roots, the seeds are

sometimes planted in a row like vegetables.

COOKING THE LEAVES. Alicia Ray writes, "Of all parts of the tree, it is the leaves that are most extensively used. The growing tips and young leaves are best. [Ed: However, we sometimes pull the leaflets off in our hands and cook them without regard to age.] Unlike other kinds of edible leaves, benzolive leaves do not become bitter as they grow older, only tougher. When you prepare the leaves, always remove them from the woody stems which do not soften. [Ed: We did not know this the first time we served them. It was like having wire in the dish.]

"The leaves can be used any way you would use spinach. One easy way to cook them is this: Steam 2 cups freshly picked leaves for just a few minutes in one cup water, seasoned with an onion, butter and salt. Vary or add other seasonings according to your taste. In India, the leaves are used in

vegetable curries, for seasoning and in pickles. Let your imagination be your guide."

Ross Haliburton in Pakistan wrote, "We planted moringa seeds in April and, with hand watering, they have grown well. The tender leaves from six plants have been regularly used like spinach since July. A group of Afghan refugee men (chiefs and nurserymen caring for small nurseries in the refugee villages) visited us. When they saw the moringa trees they immediately asked for seed. We believe this tree has potential as a green vegetable in refugee villages, where there is a general lack of greens, especially through the summer."

Dr. Warwick Kerr wrote from Brazil that while he was the president of the State University of Maranhao, he organized a group of students and professors to carry out an extension project. They planted 25,000 moringa seedlings (all descendants from one small packet we sent him in an

envelope a few years ago). "I like the moringa omelet that my wife prepares almost every morning. Collect a bowl of leaves, wash and fry for five minutes with sliced onions, garlic and salt. While this is cooling, minced tomato and onion are lightly fried then mixed with the fried moringa. Half a cup of this mix, two eggs and a spoon of any bullion soup mix are stirred and then cooked. It is delicious!" [He added that the chaya cuttings we sent made it fine and he has now distributed many plants in the community. "My wife is cooking it at least once a week and prepares it in many ways. This was the most sensational introduction: 8 small stalks in a regular airmail envelope!"]

Ronald Watts in Zimbabwe sent a copy of a letter to the editor that he wrote concerning moringa. It was published in "Productive Farming" magazine. "...I noticed several villages growing trees that I was unfamiliar with. They turned out to be *Moringa oleifera*. What was remarkable is that they were being grown for their leaves. One homestead had over 30 of

these trees growing in a circle. In 36 years of wandering around Africa this was the first time I had seen trees grown in a traditional village purely for their leaves. The farmers said that the leaves were in high demand from their neighbors particularly in times of famine. Fresh leaves appear towards the end of the dry season when green food is in short supply. This tree would seem to have immense potential for improving human diets particularly in the hot and dry areas of Zambia and Zimbabwe. ...[Moringa] would seem to have great potential for feeding livestock. Several Zambian farmers who have tried leucaena for this purpose have been disappointed because it is extremely susceptible to termite damage. Moringa has the advantage that it is less susceptible and can be grown from cuttings. A 2-meter cutting means that from the day of planting the top of the tree should be out of reach of goats." Ronald says that though palatable to termites, moringa seems to be able to resist the challenge, particularly when grown from cuttings.

We have printed many success stories with the moringa tree. But cultures differ. Mr. C. N. Okonkwo in Nigeria ran into problems with acceptance. "All the seeds germinated and some are providing pods. Unfortunately I have not been able to convince any of the farmers to eat the leaves, except myself. The reasons are three: (a) the leaves have no eye appeal, (b) the leaves have a foul smell, (c) the growing tips have no commercial value. I am not disputing the claims regarding moringa. But in a community where so many broad-leaved vegetables thrive abundantly and some fetch good money, it is not hard to see why farmers look at this scanty small-leaved tree with some doubt."

COOKING THE PODS. Alicia Ray writes, "When young, horseradish tree pods are edible whole, with a delicate flavor like asparagus. They can be used from the time they emerge from the flower cluster until they become too woody to snap easily. The largest ones usable in this way will probably be 12

to 15 inches long and 1/4 inch in diameter. At this state they can be prepared in many ways. Here are three:

1. Cut the pods into one inch lengths. Add onion, butter and salt. Boil for ten minutes or until tender.
2. Steam the pods without seasonings, then marinade in a mixture of oil, vinegar, salt, pepper, garlic and parsley.
3. An acceptable "mock asparagus" soup can be made by boiling the cut pods until tender, seasoned with onion. Add milk, thicken and season to taste. Even if the pods pass the stage where they snap easily they can still be used. You can cut them into three inch lengths, boil until tender (about 15 minutes), and eat as you would artichokes. Or you can scrape the pods to remove the woody outer fibers before cooking."

COOKING THE PEAS. Alicia Ray writes that the seeds, or

"peas," can "be used from the time they begin to form until they begin to turn yellow and their shells begin to harden. Only experience can tell you at what stage to harvest the pods for their peas.

"To open the pod, take it in both hands and twist. With your thumbnail slit open the pod along the line that appears. Remove the peas with their soft winged shells intact and as much soft white flesh as you can by scraping the inside of the pod with the side of a spoon. Place the peas and flesh in a strainer and wash well to remove the sticky, bitter film that coats them. (Or better still, blanch them for a few minutes, then pour off the water before boiling again in fresh water.) Now they are ready to use in any recipe you would use for green peas. They can be boiled as they are, seasoned with onion, butter and salt, much the same as the leaves and young pods. They can be cooked with rice as you would any bean.



"In India the peas are prepared using this recipe:

12-15 horseradish tree pods  
1 medium onion, diced  
4 cups grated coconut  
2 bouillon cubes  
2 inches ginger root  
4 T. oil or bacon grease  
1 clove garlic  
2 eggs, hard boiled  
salt, pepper to taste

"Blanch both peas and pods' flesh, drain. Remove milk from 2 1/2 cups grated coconut by squeezing water through it two or three times. Crush ginger root and garlic, save half for later. Mix peas, flesh, coconut milk, ginger and garlic together with onion, bouillon cubes, oil, salt and pepper. Bring to a boil and cook until the peas are soft, about 20 minutes. Fry remaining coconut until brown. Fry remaining half of crushed ginger root

and garlic in 2 T. oil. Dice eggs. Add coconut, ginger, garlic and eggs to first mixture, heat through. Serves 6.

THE DRY SEEDS. The dry seeds are apparently not used for human food, perhaps because the bitter coating has hardened. They are used for their oil, which is about 28% by weight. The oil can be removed by an oil press. I have heard reports that the residual cake is not safe to feed to animals, but I have not seen the results of any studies. Write to me if you have details. If an oil press is not available, seeds can be roasted or browned on a skillet, ground, then added to boiling water. The oil floats to the surface. Alicia Ray says that roasting is, however, not necessary.

Randy Creswell in Mali wrote, "The Khassonkes in Mali have been growing moringa trees for their leaves as far back as anyone's knowledge seems to go. Besides leaves, we have found good profit in a high quality edible oil readily pressable

from the seeds. We are planting 1500 moringa seedlings."

THE FLOWERS. A visitor who had spent time in the Pacific area told me recently that the flowers are eaten there.

Unfortunately, I do not recall details. Perhaps our readers can help. Alicia Ray says they are used in Haiti for a cold remedy. Water is boiled, then a cluster of flowers is placed to steep in it for about 5 minutes. Add a little sugar and drink as needed. It is very effective!

THE ROOTS. The tree is uprooted and the roots grated like horseradish. Alicia Ray says to one cup grated root add 1/2 cup white vinegar and 1/4 t. salt. "Chill for one hour. This sauce can be stored for a long time in the refrigerator." The following caution quotes from a recent review by Dr. Julia Morton in Economic Botany.

"The root, best known in India and the Far East, is extremely

pungent. When the plant is only 60 cm tall, it can be pulled up, its root scraped, ground up and vinegar and salt added to make a popular condiment much like true horseradish. ...The root bark must be completely removed since it contains two alkaloids allied to ephedrine - benzylamine (moringine), which is not physiologically active, and the toxic moringinine which acts on the sympathetic nerve endings as well as on the cardiac and smooth muscles all over the body. Also present is the potent antibiotic and fungicide, pterygospermin. The alkaloid, spirachin (a nerve paralyzant) has been found in the roots.... Even when free of bark, the condiment, in excess, may be harmful." (The key words are "in excess"-the body can detoxify small amounts of a great many things.)

**USE AS AN ANTIBIOTIC.** A study at University of San Carlos in Guatemala is summarized. Herbal applications are commonly used to treat skin infections in developing countries, although few investigations are conducted to validate scientifically their

popular use. A previous study had showed that moringa seeds are effective against skin infecting bacteria *Staphylococcus aureus* and *Pseudomonas aeruginosa* in vitro (i. e. in a test tube). This study showed that mice infected with *S. aureus* recovered as quickly with a specially prepared aqueous extract of moringa seed as with the antibiotic neomycin.

This study proves only the effectiveness of moringa as they prepared it. That preparation could be done in any country, but not with just household utensils. It was prepared by infusing 10 g powdered moringa seeds in 100 ml of 45 C water for 2 hours. The part that is a bit more complicated is reducing the 100 ml down to 10 ml by placing it in a rotavaporator. This is a very common piece of laboratory equipment which continually rotates a flask containing the liquid. An aspirator attached to a faucet produces a modest vacuum when the water is turned on. A rubber tube from the aspirator is connected to the rotavaporator, reducing the pressure and

causing the water to evaporate rather quickly without boiling it. The ointment was prepared by placing 10% of the extract in vaseline. (We can send a copy of the article to medical personnel.)

Are you in a situation where there is a shortage of antibiotics? This ointment could be prepared for use in the local community wherever there is electricity and running water. Simpler methods, better suited to preparation as needed in the home, might also be effective. I hope someone will devise and test such preparations.

ECHO can provide trial-sized quantities of *Moringa oleifera* from the trees on our farm. For those seeking other potential sources we can recommend the following: Christas Cactus, 529 W. Pima, Coolidge, AZ 85228, USA; phone 602/723-4185. Greenleaf Seeds, P.O. Box 98, Conway, MA 01341, USA; phone 413/628-4750 (No telephone orders). Of the

Jungle, P.O. Box 1801, Sebastapol, CA 95473, USA. Peace Seeds, 2385 S.E. Thompson Street, Corvallis, OR 97333, USA; phone 503/752-0421. Peter B. Dow & Co., P.O. Box 696, Gisborne 3800, NEW ZEALAND; fax (079) 78 844. Ellison Horticultural Ltd., P.O. Box 365, Nowra, N.S.W. 2541, AUSTRALIA; phone 6144-214255. Kumar International, Ajitmal 206121, Etawah, Uttar Pradesh, INDIA. Samuel Ratnam, Inland & Foreign Trading Co., Block 79A, Indus Road #04-418, SINGAPORE 169589; phone 2722711; fax 2716118.

Tom Post in Belize mentioned that his moringas are growing so well he now needs recipes. The Philippine book Learn to Eat Malunggay has 18 pages of recipes; write to ECHO for a photocopy.

Refer to Chapter 11 on Human Health for information on using moringa in water clarification.

If moringa does not already grow in your region, you may request a trial packet of the marble-sized seed. It grows wild in many places (such as Haiti and the Dominican Republic) where people do not know it is edible. The moringa is one of God's abundant resources for the struggle against world hunger.

MORINGA STENOPETALA. *Moringa oleifera*, native to India, is the number one seed in our seedbank, in terms of number of requests and positive reports. When we learned that a moringa native to Ethiopia had larger edible leaves, more drought resistance, and larger seeds (important for those using moringa to purify water), we were obviously interested. Dr. Samia Jahn shared some seed with us in the past, but our supply is very erratic; if you request seed (FOR OVERSEAS NETWORK ONLY), be aware that you may have to wait a while to receive the seed. If this is your first interest in moringa, please do initial trials with *M. oleifera*. If you have had success



with *M. oleifera*, it may be time to try this "new" species.

Michael Madany wrote from Somalia of his comparison trial with seed received from elsewhere a few years ago. "In spite of the initial rapid growth of *M. oleifera*, in drier years the species has not done well without some watering. The *M. stenopetala*, by contrast, has the lushest green foliage and continued to grow during the exceptionally long dry season from last August until this April. We began cooking leaves and young shoots in April (taste of the two species very similar). We obviously aren't eating it fast enough, since two large limbs have fallen under their own weight." Freezes damaged our one *M. stenopetala*, forcing subsequent branching from low on the trunk. Consequently, I have not seen a "normal" mature tree. Dr. Jahn says that in the Sudan *M. oleifera* develops into a slender tree, *M. stenopetala* into a round shrub-like tree. Before the first freeze, however, a few important differences became clear. The trunk is considerably

thicker at the base, the tree seems more vigorous, the leaves are larger, and if tasted raw the leaves are milder.

The more bushy *M. stenopetala* can be planted as a wind break. "Seedlings were planted in a windy corner at a spacing of 1 m. As soon as the upper branches of the tree grew broader, they were cut and the trees responded by more profuse growth of their lower branches, thus thickening the hedge. Vegetables cultivated behind it profited from this protection."

*M. stenopetala* has been grown as an ornamental in private gardens of Europeans in Kenya, reaching 10-12 meters and their trunk diameter is at least 2-3 times as thick as that of *M. oleifera* in Sudan. In Ethiopia it is cultivated as high as 1800 meters (5400 feet), where people use ash as the main fertilizer. By the end of a long dry season the trees may have lost their leaves.

We have been disappointed that ECHO's 8-year-old *M. stenopetala* tree has not yet flowered. We thought it was due to its having been badly damaged by two freezes. Dr. Jahn cites reports that *M. stenopetala* trees are not as quick to set flowers as *M. oleifera*. In Sudan the first flowers appeared after 2 1/2 years, compared to 11 months for *M. oleifera*. Charlie Forst in Haiti reported that his tree flowered in 15 months, grown from a cutting, which may make the difference. In the central plateau of Haiti, the low-branching, large-leaved *M. stenopetala* has far superior growth in the dry season. It is in full leaf after months without rain, while *M. oleifera* suffers after severe drought.

Michael Madany wrote again, this time from Kenya. "Since I am quoted in EDN with regard to our experience with *Moringa stenopetala* in southern Somalia, I'd like to send a few more comments. The last time I saw the trees we planted in February 1986 was January 1990. They had only flowered

once (in 1987 or 1988; only a few flowers) and never set seed. Thus, whenever I wanted to plant more, I was obliged to use cuttings. As far as a source of green vegetable matter in the dry season, the tree surpasses its domestic relative *Moringa oleifera* in that climate (bimodal rainfall of 400-800 mm; 20-40 C). However, for the purpose of producing water-purifying seeds it seems to be not so successful, at least in the first 5 years. I am mystified as to the reasons for this. The provenance for our trees was over 500 km west at a considerably higher elevation." Michael mentions that during the civil war in Somalia the project buildings were destroyed and "all the trees in our garden were cut down."

Jay Ram wrote from the Pacific Neem Mission in Hawaii. "My *Moringa stenopetala* tree is now 10 feet tall and growing vigorously. I really share your enthusiasm for this wonderful tree. It is one of the best species we have come across. Fast growing with good form, and high palatability. In fact, I

commonly will eat the boiled leaves by themselves, [something I do not do with *Moringa oleifera* which is common on the island]."

There is another interesting difference. The roots of *M. oleifera* are used as a condiment similar to horseradish. With *M. stenopetala* it is the bark that is so used.

Dr. Jahn reports on work in the Sudan which shows that optimum light for germination of all moringa species is half shade. When sown in the hotter weather of mid-April, germination percentages for *M. stenopetala* and *M. oleifera* were only 54 and 40 percent, compared to 92 and 94 percent in half shade. During the cool dry season there was little difference. Both moringa species can be started from cuttings. However, trees grown from cuttings are known to have much shorter roots. Where longer roots are an advantage for stabilization or access to water, seedlings are clearly

preferable.

ECHO does not have a regular source for *M. stenopetala*. Watch future EDNs for availability, or write to be on our waiting list (send last date we should send seed).

THE NEEM TREE (AZADIRACHTA INDICA) FOR REFORESTATION AND AN EFFECTIVE INSECTICIDE. I first encountered the neem tree in Haiti, where hundreds have been planted along highways. I understand that it was chosen in part because it would grow very quickly and encourage the people that reforestation was possible. When I last visited Grace Mountain Mission in Port-au-Prince, there were 15-20 foot neem trees where there had been nothing a year before! Its seeds contain an especially effective natural insecticide. See Chapter 8 on Plant Protection for more on using neem as an insecticide.

The tree originated in India or Burma, where it is used widely for its insecticidal and medicinal properties. It is also grown in much of Africa, primarily for firewood. Seeds contain up to 40% oil which can be used for soap or lamp fuel. The residual neem cake is a good fertilizer with some nematicidal properties. (It is the neem oil that is primarily used as an insecticide; water extracts of powdered kernels also can be used in this way.) Neem is fast-growing and drought resistant, excellent for reforestation of semiarid lands. It is an evergreen (except in extreme drought) and valued for its shade- especially in cities- and windbreak protection. It grows best in deep, well-drained sandy areas, but thrives even on acid soils. It may fail in silty or clay soils and in waterlogged sites. To plant, pick fully ripe seeds directly from the tree and plant immediately. The trees may be direct sown or transplanted, and they benefit greatly from tillage, weeding, irrigation, and some fertilization in the first few months of growth (or after transplanting). Neem has been established in many countries

throughout the tropics; there is a good chance you may find seed in country if you make inquiries.

A good source of additional information is the National Academy of Sciences publication *Neem: A Tree for Solving Global Problems*. It is available from: BOSTID Publications-HA 476, 2101 Constitution Avenue N. W., Washington, D.C. 20418, USA. ECHO now has it available for sale for \$19.00 plus \$2.00 postage in the USA. If you work with small farmers in the developing world, write ECHO before ordering about how this book would be useful in your work; you may qualify for a substantial discount.

Ordering neem seed can be difficult. The seeds may be viable for less than a month. You are strongly encouraged to find local sources of the seed. When ECHO receives an order, we hold the orders until either our tree produces (which it does not do every year) or we obtain a fresh shipment from



overseas. For those visiting ECHO, we often have seedlings available in our nursery. We also refer you to some potential U.S. sources:

EXTRACT: AgriDyne Technologies, Inc., 417 Wakara Way, Salt Lake City, UT 84108, (801)583-3500; fax 583-2945. Ringer, Valley View Road, Eden Prairie, MN 55344. Jim Walter, W.R. Grace Washington Research Center, 7379 Route 32, Columbia, MD 20861, (410)531-4000.

SEED: Seeds are only available on a seasonable basis, as they must be planted within 3-4 weeks of harvest.

Agricultural Research Service (ARS), US Department of Agriculture (USDA), 13601 Old Cutler Road, Miami, FL 33158, (305)238-9321. The Kerr Center for Sustainable Agriculture, Vero Beach Research Station, 7055 Cherry Lane, Vero Beach, FL 32966, (407)562-3802. Robert Barnum, Possum Trot

Nursery, 14955 S.W. 214th Street, Miami, FL 33187, (305)251-5040. FLAG Unit, International Livestock Centre for Africa(ILCA), P.O. Box 5689, Addis Ababa, Ethiopia. The Tree Seed Program, Ministry of Energy and Regional Development, P.O. Box 21522, Nairobi, Kenya.

SEEDLINGS: Saleem Ahmed, East-West Center, 1777 East-West Road, Honolulu, Hawaii 96848, USA; phone 808/944-7111. Robert Barnum, Possum Trot Nursery, 14955 S.W. 214th Street, Miami, FL 33187; phone 305/251-5040. John Conrick, Winter Park, FL; phone 407/384-7616. Chip Gardner, CA; phone 209/674-9543. Pacific Tree Farms, 4301 Lynnwood Drive, Chula Vista, CA 92010 (\$36 per plant, no seeds). Marlin Huffman, Plantation Botanicals, Inc., PO Box 128, Felda, FL 33930; 813/675-2984, fax: 675-4591, (top quality West African germplasm from Larson, planted mid-1991). Sandy Mush Herb Nursery, Rt. 2, Surret Cove Rd, Leicester, NC 28748; 704/683-2014, (root cuttings).

## INFORMATION:

The Neem Association, 1511 Oneco Avenue, Winter Park, FL 32789, USA. (May be closed.) Axel Bosselmann, POB 1166, Charters Towers, 4820 Qld., AUSTRALIA (publishes Neem Notes).

OVERSEAS SEED SOURCES (for those working overseas only please):

Jean Hanson, ILCA, FLAG Unit, P. O. Box 5689, Addis Ababa, ETHIOPIA.

The Tree Seed Program, Ministry of Energy & Regional Development, P. O. Box 21552, Nairobi, KENYA.

Henry Doubleday Research Association, Ryton-on-Dunsmore, Coventry, CV8 3LG, UK; phone 0203-303517. H.E. Ostmark, Ph.D., Director of Research,

FHA (Fundacin Hondurea de Investigacin Agrcola, Apartado Postal 2067, San Pedro Sula, HONDURAS; phone 504/68-2078, 68-2470; fax 504/68-2313 (willing to fill requests for Neem from Central America. Available September only).

Rene D. Haller, Baobab Farm Limited, P.O. Box 81995, Mombasa, KENYA; Telex 21265; phone 485729/754/501.

Roy B. McKenzie, McKenzie Agrisystems, Ltd., PO Box 95979, Mombasa, KENYA; phone 433460 Mombasa, 747131 Nairobi; fax 432309 Mombasa.

Tanzania, Forestry Research Institute, Silviculture Research Centre, P.O. Box 95, Lushoto, TANZANIA.

Forestry Research Institute of Malawi, P.O. Box 270, Zomba, MALAWI; phone 522866/522548.

Kenya Forestry Seed Centre, Kenya Forestry Research

Institute, P.O. Box 20412, Nairobi, KENYA, phone: 0154-32541.

Regional Seed Centre, Forestry Commission, Forest Research Centre, P.O. Box H.G. 595 Highlands, Harare, ZIMBABWE; phone 47070/46878/9.

Nathanael Ariyo Olonire, P.O. Box 2674, Sokoto, NIGERIA, West Africa (bulk neem seed, leaves etc.).

Professor S.X. Charles, Director, "Thayagam", 172 K.P. Road, NAGERCOIL-629001, Kanyakumari District, Tamil Nadu, S. INDIA.

India Nursery & Seeds Sales Corporation, P.O. Box 4314, 36/962 DDA Flats, Kalkaji, New Delhi-19, INDIA (neem seed bulk).

Shivalik Seeds Corporation, 47 Panditwari, P.O. Prem Nagar,

Dehra Dun -248 007 (UP), INDIA; phone 91 135683348; fax 91 135 29944.

Kimberly Seeds, 51 King Edward Rd, Osborne Park 6017, AUSTRALIA; phone (09) 4464377 (neem seed bulk).

Green Gold Intl., 14071/5, Prabhat Nagar, Dholewal, Ludhiana 141003, INDIA; phone 0091(161)535461; fax 009(161)28515, 34793 (neem seed or stem cuttings from superior seeds for rooting under mist).

CROSS-POLLINATE TO GET NEEM SEED. Norman Siegel in Mexico asked about a neem tree that did not bear seed. They ended up with only one tree from the seed packet we sent. This can easily happen because neem seeds are only viable for perhaps a month. "We have been reproducing it by cuttings but it has not yet seeded." The problem may be that neem must be cross-pollinated with an unrelated neem tree. We

planted two neem trees at ECHO, about 200 meters apart. We waited in vain for fruit to set the first two years after they reached blooming age. The next year we had a small tree in a pot that was blooming, so positioned it on a small platform near one side of the larger tree. That year we had fruits in a circumference of a few feet around where that pot had sat. I have never read of this requirement, but in most real-life situations other trees would be nearby.

We planted a second tree beside our one tree. Last year it bloomed, and both trees produced fruit. We grafted this tree onto the more distant tree. The tiny grafts gave a few blossoms and I believe we got some fruit. Our Edible Landscape Nursery is preparing to sell neem trees with an unrelated graft so that home owners who only have room for one tree can get seed. A veneer graft takes well.

By the way, a 26 F freeze had this effect on our seven-foot

neem tree: I had water spraying on the tree that night at about 4 feet. It was fine from there down, but after some weeks the leaves above 4 feet dropped. Eventually all parts that were not protected with water spray died.

NEEM IN AFRICA. Ralph Kusserow in Tanzania wrote, "After reading about the neem tree in EDN I really wanted to try it, but was afraid to order seed because it is viable for such a short time. Then I found that we have it here in Tanzania, though not in our area. In case you have anyone else in a Swahili-speaking area, it might help to know that it is called mwarobaini in Swahili. That means the "forty tree," so called because it supposedly makes medicines to treat 40 diseases. ...My main interest in neem is your report that the leaves can make a tea to deter termites. One of our friends has built a house every year for three years because of termite damage to the grass roof. I am anxious to see if neem leaf juice might be used in this situation."



PAULOWNIA, CHINA'S WONDER TREE. I asked Zhu Zhachua with the Chinese Academy of Forestry in Beijing, China for Paulownia seed after reading about it in IDRC Reports. [IDRC Reports is published by the Canadian aid agency, IDRC. Every issue is interesting. Contact IDRC, P.O. Box 8500, Ottawa, Ontario, CANADA K1G 3H9; internet mag@idrc.ca.] Two species of this broad leaf tree, Paulownia glabrata and P. elongata, are now widely planted in China, where it is adapted to most of their climatic zones. A 15 cm long root cutting can grow 18 feet (6 m) the first season. A 5-year-old tree can reach 17 m and have a 30 cm trunk diameter. Leaves make good animal fodder. It is planted for timber (though not of the highest quality) and firewood. It is intercropped with crops such as wheat, corn, millet and vegetables, to protect against wind, for shade, and as a green manure. Intercropped land in China has increased from 20,000 hectares in 1970 to 1.3 million today. For example, using 10 m rows and 5 m spacing in a wheat field, the yield of wheat was the same as in open-

field cultivation. When the distance between the rows was increased to 20-40 m, the yield actually increased 7-10%. There are Paulownia plantations in the USA for export to Japan. ECHO does not have Paulownia seed; we refer you to Dr. Peter Beckjord at the National Paulownia Center, 10908 Dresden Dr., Beltsville, MD 20705, USA; phone 301/937-4635. You must send him US\$1 to cover postage for basic instructions, a brochure, and an introductory packet of 500-1000 seeds. He also has much more information available if your trials go well.

**SESBANIA ACULEATA FOR FIREWOOD THAT GROWS UNDER TOUGH CONDITIONS.** Bob Burns in Bangladesh sent us a few seeds of this plant, also called *Sesbania bispinosa*, prickly sesban and dhaincha. According to the book *Firewood Crops* by the National Academy of Sciences, this is a quick-growing shrub that can produce a low-density firewood in only six months. In Vietnam it is grown in rice fields and its stems

harvested for firewood before the rice crop is planted. It is a legume that nodulates vigorously. Its fibers are very similar to birch, one of the best trees for paper. Stems can be processed into a jute-like fiber, used for making fishing nets, sacks and sails. Other uses include for windbreaks, erosion control, cover crop and green manure. The leaves reportedly make good cattle fodder. It is well adapted to difficult soils. It will grow on saline and alkaline wastelands and wet, almost waterlogged soils, even in areas that often remain barren for want of suitable crops. No seed treatment is required. It grows so well that it is excellent at suppressing vigorous weeds such as *Imperata cylindrica*. (If you did not want the tree, it might itself become a serious weed pest.)

**SESBANIA SESBAN RECOMMENDED FOR ALLEY FARMING AT HIGHER ELEVATIONS.** (Common names: sesban, Egyptian rattle pod, suriminta, soriminta.) It is a great help to us when scientists in ECHO's network take the initiative to let us know

about items of likely interest to our readers. A good example of this is a letter from Simon Chater at the International Livestock Centre for Africa (ILCA). He wrote, "A good alternative to leucaena for alley farming in highland areas (above 1800 meters) seems to be *Sesbania sesban*. We are growing this in hedgerows on broadbeds and ridges made with specially adapted ploughs in heavy clay soil. They are yielding 800 kg to 6 tonnes per hectare per year, depending on the cropping pattern. Under difficult highland conditions (frost, hail) in soils prone to erosion and waterlogging, this browse legume tree looks to be the most promising thing we have yet tried."

According to a paper from NFTA, *Sesbanias: A Treasure of Diversity*, *sesban* is "adapted to arid and semi-arid regions up to about 1200 m and to acid soils." I asked Nancy Glover at NFTA about this difference in recommended altitudes. Nancy said that there is a lot of confusion about limitations of

altitude. Reported altitude requirements are so dependent on the latitude that they are often not at all comparable. It is possible that the two countries have quite different varieties.

The following information comes from the National Academy of Sciences book *Firewood Crops*, Vol. II. Sesban is a fast-growing, short-lived tree that regenerates rapidly after pruning. It is a copiously branched shrub growing no more than 6 meters. The wood yields an excellent gunpowder charcoal. Stems have been used for arrows, pipes, roofing for huts and, in fact, sesban is cultivated as a substitute for bamboo. Flowers are eaten as a vegetable, leaves eaten in Thailand, and the high protein seeds (33.7% protein) are a famine food in India (seeds must be soaked 3 days then cooked for half an hour to remove the toxic constituent caravanine). In India it is planted as a green manure in both dry and wet rice fields, plowed under before planting the rice. It is also used in India as a windbreak and shade for

vegetables and as a support for grape, black pepper and cucurbits. It withstands acid soils, periodic flooding and waterlogging. It can endure 0.4-1% salt as a seedling and 0.9-1.4% near maturity. No seed treatment is required before planting. There are a lot of insect and fungus problems. The tasty leaves must be protected from cattle. (ILCA in Ethiopia originally supplied ECHO with some seed. They have since merged with ILRAD in Kenya to form ILRI, the International Livestock Research Institute. You may still be able to obtain seeds from ILRI at P.O. Box 5689, Addis Ababa, ETHIOPIA.)

**SESBANIA GRANDIFLORA.** Eliazar T. Rose of the New Hope Leprosy Trust, India, wrote, "I keep reading of people trying and promoting Moringa trees and from the seeds you sent us we have seen hundreds of trees extended. But wherever moringa grows here so does the *Sesbania grandiflora*. This is strong in the winds, grows just as fast, produces far more edible beans and flowers and is more attractive as fodder to

goats and cows. If anything, after many years I would say first to sesbania and second to moringa."

[Editor: These are valuable comments. It shows how different two locations can be. When I planted the first moringa tree at ECHO I also planted a *Sesbania grandiflora* beside it. It indeed grew just as quickly. That fall a tiny "inch worm" totally defoliated the tree. When it happened the second year the tree died. We have tried many times since then. Each time we have had to spray the tree frequently to control the inch worms and even then eventually lost the tree to nematodes, which are as bad in our sandy soil as they ever get. It is one of the few important trees we just cannot seem to grow. We usually can send a small packet of seeds (which we obtain elsewhere) if you would like to see how it does in your area. If you need information on its use, make note of that with your request.]

TAGASASTE, CHAMAECYTISUS PALMENSIS, A TEMPERATE COUNTERPART OF LEUCAENA. The following is abstracted from the NFTA description. A small, shrubby tree from the extremely arid volcanic slopes of the Canary Islands holds promise for fodder, firewood and other uses in tropical highlands, Mediterranean climates and temperate regions. There are no thorns. Canary Island farmers have depended for centuries on tagasaste as fodder during the long, dry summers. New Zealand and Australian farmers are trying it today in cut-and-carry systems. Leaves contain 20-24% protein. All grazing animals and pigs and poultry readily consume the leaves. There are no reports of toxicity. Plant as a hedge for wind and sun protection. Coppicing ability is excellent (i.e. they come back when cut). It is the first tree to flower in the spring, so it is excellent for bees. Wood is popular for lathe work. It has potential for alley cropping. During the 2-3 year establishing phase, pruning back to ground level encourages multiple stems and self-protection when grazing



commences. Sheep may eat the bark and kill trees. Tagasaste prefers sandy soils, but thrives on gravels, loams, limestone and laterites, as well as slag heaps and mining dumps. It does best with an annual rainfall of 350-1600 mm and soil pH of 5.0-7.0. Soils must be free draining to prevent root rot. Can survive winters of -9 degrees C. Can be inoculated with cowpea inoculant. Few insect problems. (ECHO has difficulties getting seed of tagasaste. If it grows in your area, we would like to hear from you and send you our seed import permit.)

## **Fruit and nut species**

FRUITS OF WARM CLIMATES by Julia Morton is an authoritative source for information on sub/tropical fruits from around the world. Possibly our most-used reference book at ECHO, this 505-page hardcover book has comprehensive information, excellent photographs, and practical growing hints for over 150 well- and lesser-known fruits and related

species. It offers regional names, complete information on varieties, food value and toxicities, propagation, harvesting and storage, and medicinal uses, etc. of the various fruits. It is an indispensable resource for anyone who works extensively with tropical fruit production. Order from ECHO for US\$75 plus postage (\$5.50 within the US; \$10 to Canada or Mexico) by credit card or check drawn on a US bank. Due to the weight and value of this book, we cannot ship overseas.

"TROPICAL FRUIT PRODUCTION AND RESEARCH" is a very popular graduate course that has been offered every other year at the University of Florida's Tropical Research and Education Center by Dr. Carl Campbell. When ECHO hired Scott Sherman as Assistant Director in 1988 the first thing he did was take that course. Although Carl is "retired" he still teams up with Dr. Jonathan Crane, the man who assumed his position, to offer the course in the summer (approximately mid-May to mid-June). This course is geared toward highly

motivated students. You must register for credit through the university and pay tuition (which will be out-of-state for most of you). There are no special scholarships. A B.S. degree in a plant or agricultural science is a prerequisite (with some exceptions). Enrollment is limited. Lectures and field trips take place between 8 and 5 weekdays, so the course requires a full-time commitment. Contact Dr. Crane at TREC, 18905 S.W. 280 St., Homestead, FL 33031, USA; phone 305/246-6393; fax 305/246-7003. The course will be offered in 1996.

ECHO'S VIDEO SERIES ON TROPICAL FRUITS. Dr. Carl Campbell is well known to readers of EDN. His answers to your tropical fruit questions have appeared in many issues. Until his recent retirement, Carl was professor of tropical fruit at the University of Florida, responsible for teaching, research and extension. He is also known to many Floridians for his popularity on the speaking circuit at the many tropical fruit clubs in this State. His knowledge of and enthusiasm for the

subject of tropical fruit is contagious.

Imagine standing under a mango tree with Carl while he shared the most interesting and helpful things he knew about mangoes. Then envision going to other trees and doing the same thing for 10, 20 or 30 minutes: avocado, canistel, loquat, macadamia etc. I had this privilege during four different seasons, videotaping his discussion. ECHO intern Mary Cockram, a communications and agriculture graduate of Cornell, then spent hours editing it down to approximately 8 hours of teaching. Now you too can meet Carl under some of his favorite trees!

The first tape in the series, called "Introduction to Tropical Fruit," was made last. We found that people coming to ECHO to study before heading overseas were so unfamiliar with tropical fruits that they did not even know it was a subject they should want to learn about. I must admit that 20 years

ago, when reading the account of Adam and Eve in the Garden of Eden, I would envision them eating apples, pears, cherries and other temperate fruits. Most Americans would be hard pressed to even name a tropical fruit other than banana, pineapple, mango, and avocado. So we asked Carl to put together a 70-minute slide presentation. Fruits of the lowlands, middle elevations and then high elevations are discussed in order, each divided into major fruits, lesser known fruits with considerable potential, and locally important fruits. Every time I see it I am not only enthused again for the potential of tropical fruits in development projects, but am struck with awe at the richness of the world God has created for our joy and benefit.

The only other tape that was not made "standing under the trees" is the one on papaya and coconut. Carl's discussion of these two fruits is based around a series of slides.

The tape on grafting tropical fruit will be of special interest to many of you. Closeup photography and Carl's running comments show several of the most useful grafting techniques. After viewing this tape a few times, then getting some hands- on practice, you should have a powerful new tool for your ministry. You can use the tape in teaching if you provide the commentary in the local language.

TAPE # 1 - (73:03 minutes) Introduction to Tropical Fruit.

TAPE # 2 - (81:58 min). Part I. Grafting Tropical Fruit (60:08 min); Part II. Avocados (21:50 min).

TAPE # 3 - (85:13 min). Part I. Guava, pineapple and macadamia (34:30 min); Part II. Mamey sapote, sapodilla, eugenia family, jaboticaba, velvet apple, black sapote, white sapote, white mombin, strawberry tree (50:43 min).

TAPE # 4 - (79:02 min). Part I. Atemoya, passion fruit, inga, loquat and naranjilla (29:15 min); Part II. Akee, tamarind, jujube, carissa (21:16 min); Part III. Carambola, canistel, monstera, barbados cherry (28:31).

TAPE # 5 - (69:12 min). Part I. Mangoes (40:00 min); Part II. Papaya, coconut (29:12 min).

TAPE # 6 - (67:36 min). Part I. Banana and jackfruit (26:00 min); Part II. A conversation with Carl Campbell about tropical fruit and development (41:36 min).

ORDERING INFORMATION. Several have written asking us to remember that the world uses three video systems. We have done so, though the duplicating costs for other than NTSC tapes (NTSC is the system used in the USA) are much higher. Each NTSC tape sells for \$29.95 plus shipping and handling; all six for \$150. Prices in the other two systems, PAL and

SECAM, are \$40 per tape, \$200 per set. FOR POSTAGE: contact ECHO. Payment must be in US dollars, either a check drawn on a US bank or your credit card (send authorization to use it and expiration date). Please add 6% sales tax for orders shipped to Florida addresses.

We are offering a subsidized price for only those readers who work directly through non-profit organizations to help peasant farmers or urban gardeners in the Third World. These qualify for a 50% discount on the price of tapes. Explain the nature of your work and name of the non-profit organization (unless it is on file with your EDN application). This discount applies also to PAL or SECAM, although in SECAM that price represents less than our costs of reproduction alone.

We are excited at the potential of video for taking the training to you. (Of course people studying at ECHO can study them here at no cost.) Other series are being planned. We welcome



suggested topics. Maybe you could even offer some raw footage of your own on a special local technique that we could include in a future video. We especially want an evaluation of this series from those who use them.

TROPICAL AND SUBTROPICAL FRUIT TREES FOR ARID REGIONS. I spent some time in conversation with Dr. Carl Campbell recently about fruit trees for areas that are arid for much of the year. Dr. Campbell, researcher and state extensionist for tropical fruit in Florida, has been the source of other information in these pages. Sentences or phrases preceded by an asterisk mean that we need more information that some of you may be able to supply.

Balanites. This desert date is one of the toughest of trees in Ethiopia and Somalia. It is "survival fare," as the edible small fruit is bitter, but it is high in carbohydrate and is not toxic.

\*Who can get us some seed to share? Prickly pear cactus,

Opuntia spp., can be quite productive. [Popenoe's Manual of Tropical and Subtropical Fruits (MTSF) says that the best varieties can produce on lean sandy or rocky soil, ill-suited for growing ordinary crops, with yields up to 18,000 pounds of fruit to the acre which would contain about 2500 pounds of sugar.] \*Varieties have been selected but we have little information on this. There is some commercial production in California, Italy and North Africa. The fruits are quite tasty, about the size of a lemon. They can be started from seed, but more commonly from joints. Carl thinks quite highly of this fruit. MTSF says, "An important advantage is the regularity of the yearly crop. They begin to bear about 3 years after planting and continue for many years". If you cannot find plants locally you can write us for seed. I have not yet located a supply, so be patient. Indian jujube (*Zizyphus jujuba*) tolerates both fairly wet or fairly dry conditions and will grow in near desert conditions. It is a very vigorous and hearty tree that will take about anything except freezes. It is extremely

productive and has few disease problems. Though it grows to a good size, it can be pruned into any shape and would be good for espalier. People feed leaves to goats during dry weather. Carl knows of no named varieties. Do not confuse this with the Chinese jujube which is hardy even into the Ohio valley in the USA but will not do well in warm climates like southern Florida. ECHO has seed each year around February. Imbe (*Garcinia livingstonei*) grows in some pretty arid places and is fairly productive, though it is not a desert tree. It has a bulbous base underground like many arid and fire-resistant trees. It is so closely related to the mangosteen that it can be used as mangosteen rootstock. Quoting from Sturrock's *Fruits for Southern Florida*, it is "quite hardy in southern Florida and grows equally well on the acid sandy soils and alkaline rock soils. [To be hardy here means it can stand high rain and humidity also.] (Several generations of) trees grown from seed were quite fruitful with little variation in fruits. There are male and female trees. The stiff, unsymmetrical growth and

the grey-green stiff foliage give it an unusual and striking appearance. ...The small orange-colored fruits have a thick tough skin and a very large seed. The small amount of juicy acidulous pulp has a pleasant flavor. It is, however, more a curiosity than an economic fruit."

APPLES FOR THE HIGHLAND TROPICS. We became acquainted with Jim Abbott in 1982 when we were looking for someone willing to give attention to small overseas orders. Some of you will remember the "bench grafted" apple trees that he offered some years ago. These apple roots with scions grafted to them were so small that up to 30 could be shipped in a package the size of a shoe box. There were a few successes, but most shipments had died in transit.

I called Jim for an update. He has had better luck with bench grafted trees that were ordered in sufficient quantity to ship by air freight (faster than regular airmail). However, several

of them still have died within a few months.

Now he prefers to dig up established but quite young trees, much younger than would be dug for domestic shipment. Typically he chooses plants 12-18 inches tall that were budded in May or July and dug in the winter. They are still small enough that a person could fit 100 trees into a suitcase.

Advance planning is essential, even with small orders. Jim likes to begin correspondence early in the year, but can only ship when the trees are dormant (mid-December through March). If you travel to the States, it would be ideal to talk with him by phone. Whenever possible it is best to transport the trees in a suitcase when returning home or when someone is visiting. Otherwise there may need to be an exchange of letters to determine just how the trees are to be shipped and how many dollars to send him in advance to cover shipping- which can be more than the price of the trees. Jim figures that

the maximum safe time for trees to be in the mail is about two weeks. The trees themselves are US\$2.50. (They would be less if you are ordering several hundred, but unless apples are already proven in your area I would hesitate to start with that many.)

Jim can provide a phytosanitary certificate if requested. You will need to check with your government to obtain necessary permits for importing trees. A very small hand-carried or mailed package might be allowed into some countries, but the risk of a large, expensive shipment dying in customs is too great not to investigate beforehand.

Recently Jim has sent fairly large orders to Ethiopia, and 28,000 trees to Honduras where a Japanese project has built a cooler to keep trees dormant until planting season. In Honduras (I believe at about 7,000 feet) the Excelsior plum and hood pear are also doing well. Chet Thomas wrote that the

trees in Project Global Village's planting high in the mountains in Honduras did not need to be defoliated to blossom. They seemed to bloom frequently, even while apples were ripening on the tree. I heard the same thing from a site in Rwanda. Jim reported that blueberries are apparently doing well at one site in Honduras.

So what should you do? (1) I hate to ever say "never," but I would not bother with subtropical "temperate" fruits at elevations less than 3,000 feet (1,000 m). The cutoff elevation will be higher near the equator than at higher latitudes. Islands may have more moderate climates than sites well inland on continents. If I was at 6,000 feet I would begin to think of subtropical "temperate" fruits very seriously. (2) Write to Jim Abbott early enough to allow a few exchanges of correspondence. He will need to have payment for trees and shipping in advance. The address is Monticello Garden Nursery, 1200 Mahan Dr., Monticello, FL 32344, USA; phone

904/997-5482 or - 7202; fax 904/997-6759. (3) If you want them to come airfreight, how is word to be gotten to you quickly that they have been sent? It is much easier if you or a friend can hand-carry the trees. (4) Start small.

**CASHEW AS A CASH CROP: IS IT AS GOOD AS IT APPEARS?**  
You would be surprised how often we receive a question similar to this. It does indeed do very well on poor soil. However, Dr. Campbell has mentioned to me that it is seldom a successful development project. One serious problem is the terribly toxic fumes that are produced during processing. They can be safely processed on a large scale, but it is not simple to do. The Natural Resources Institute (Publications Distribution Office, NRI, Central Avenue, Chatham Maritime, Kent, ME4 4TB, UK) has some intermediate technology designs for processing cashews. My guess looking at the picture is that it would cost several thousand dollars.



I was replying to a question on cashews from Tom Taylor in Guyana when Dr. Frank Martin came by to begin work on a new teaching video for us on tropical root crops. I asked his opinion. Dr. Martin said that while cashew is often touted for areas where soils are poor, the tree has serious fruit setting problems. If there is excess moisture during flowering the fruit will not form. He gave this example. "A project I was consulting with in northern Haiti asked me to look at cashews. I questioned many farmers very carefully. It turns out that even though the climate is dry, there is enough condensation of water at night to impede fruit development." That does not mean it is never a good choice. "I have never seen it grow as well as it does in central Panama." Dr. Martin said that if you have not already had a successful experience with cashews (including good fruit set) in the particular area being considered, be careful.

He also pointed out that cashew trees are associated with

poverty worldwide. There is so much labor involved that there is little income produced per person. So it has little promise unless there is cheap labor. "It is a poor person's crop and a crop for poor soils." If you know of a cashew project that would lead you to a different opinion, we would like to hear about it.

FLORIDA CITRUS PUBLICATIONS. Ed Noyes in Zaire wrote us about problems he was having with citrus, wondering if extension bulletins in Florida covered the topic. This led us to the Fruit Crops Extension office. (They used to publish a range of booklets on various topics, but that service is no longer available.) The information is now available for sale in book form; some titles are: Nutrition of FL Citrus, FL Dooryard Citrus, Rootstocks for FL Citrus, Citrus Disease and Insect Flashcards; FL Citrus Varieties, and Citrus Spray Guide. Each costs about \$10 plus postage. Order from Florida Cooperative Extension; 2109 Fifield Hall; Gainesville, FL 32611, USA; phone 800/226-1764; fax 904/392-2628. [If you write to

ECHO for information on a particular fruit, we may send you the 2-page University of Florida's Fruit Crops Fact Sheet on that plant.]

SOME NOTES ON GUAVAS from Wilson Popenoe's (out of print) classic book Manual of Tropical and Subtropical Fruits: "The guava is used primarily for jelly-making and other cooking purposes." "It is one of the least exacting of all tropical fruits in cultural requirements." "The guava succeeds on nearly every type of soil." "Plants should be set 10-15 feet apart." "It is the custom to propagate by seed, but choice varieties must be perpetuated vegetatively." "Both shield budding and patch budding are successful." "A simple method of propagation is to cut the soil 2-3 feet from the tree, severing the roots. Sprouts will soon make their appearance. When they are of suitable size they may be transplanted, giving a tree exactly like the parent tree." "The guava is subject to numerous insect and fungus enemies." "Unlike the

preceding species, the strawberry guava is subtropical and can be grown wherever citrus succeeds."

THE JABOTICABA TREE, MYRCIARIA CAULIFLORA. A lot of local interest and publicity came our way with the opening of ECHO's "Edible Landscape Nursery." Our goal is to raise a portion of the expense of running this ministry by selling edible plants for both the yards and gardens of people in our local community. At the same time we are having a lot of fun acquainting our neighbors with some of the wonderful plants with which God has blessed our world.

A personal favorite is the jaboticaba tree. If I could rename it, I would call it "the grape tree." Early each spring the tree is loaded with purple fruits the size of large grapes. Fruits contain one seed which is larger than a grape seed but small enough that there is a lot of flesh to enjoy. The flavor and texture remind me somewhat of a muscadine grape. Uses are

also similar to muscadine grapes. They can be eaten fresh, but the peel is tough enough that people often spit it out. They can be processed in ways similar to grapes, such as in jelly or wine. The visual appeal of the tree is striking. The trunk and larger branches, which are attractive in their own right, are suddenly covered with fluffy blossoms (in contrast to most fruit trees which set fruit on smaller branches). Soon the purple fruits almost hide the larger limbs.

There are drawbacks. The major limitation is that it is so slow to produce. Although Julia Morton's *Fruits of Warm Climates* mentions side veneer grafting, inarching and air layering, the conventional wisdom around here is that one might just as well start from a seedling. Seedlings are slow to begin bearing, typically about 9 years. Trees are very slow growing, reaching a maximum height of perhaps 30-40 feet. A second limitation is that they are not for the hot lowlands. They like a mountainous or subtropical area. At ECHO they only blossom

during the coolest few months of the year. In some ideal (cooler) locations they produce several times a year. The tree is not harmed by frosts, nor by a freeze if it is light enough that it would not kill citrus.

If the weather cooperates, ECHO can share seeds each March. We will combine requests and fill at harvest time. Be sure to plant the seeds immediately, as they do not have a long life.

ARE MACADAMIA NUTS A GOOD CROP FOR BELIZE? Several have expressed an interest in macadamia nuts as a cash crop in one country or another, so our answer to this question may be of interest to many. Carl Campbell says, "Poor yield is a very common problem where people have planted in the Americas. In Hawaii they figure their break even point at about 100 pounds of nuts per mature tree. By comparison, in Florida we get 15-20 pounds. Macadamia trees seem to do best in the areas where coffee does best. Processing is a

problem too. People have put in little plantings, only to find that they cannot get the nuts processed. Some have even shipped from Central America to Hawaii for processing. Many of those who have been in it the longest seem discouraged." Carl adds that *Macadamia tetrafolia*, the rough spiny leafed and rough shelled macadamia, is the preferred rootstock. *M. integrifolia* is the other macadamia.

COMMENTS ON WORMS AND POLYEMBRYONY IN MANGOES. William Boykin in Zambia wrote, "We had 40 trees of peach mangoes. They are a lovely orange color, have very little fiber and are delicious. For four years we had only a small crop and nearly all that did mature were full of worms. On the other hand, the common local mangoes hardly ever have worms-but they are very stringy and fibrous. As a result we had most of the peach mangoes cut down and planted the common variety. Is there anything we can do to control the worms in the few remaining peach mangoes?"

I phoned Dr. Carl Campbell. As usual, I learned more than just what I phoned to ask. Carl said the pest is most likely the larvae of the fruit fly, most species of which like mangoes. There is very little that can be done. It is considered impractical to spray an entire area to get rid of the fruit fly. However, in Central America some folks get a crude molasses from the sugar mill at very low cost and mix malathion with it. Carl does not know the proportions or dilution. A swath is then sprayed onto leaves as a person with a backpack sprayer walks down the row of trees. Because it is a bait, it is not necessary to cover all the leaves or even every tree. Flies are attracted to the bait and are killed by the insecticide. He has seen it work fairly well with the Mexican fruit fly in Honduras. To make sure your species of fruit fly is attracted to the bait, try placing molasses on a few leaves and see if it attracts flies. I asked at what stage this should be done. Carl replied that control would be important about 3-4 weeks before the fruit is mature. Carl referred me to Dr. Jorge Pena, a specialist in



insect control with tropical fruit, to answer my question of, "Why is it not used in Florida if it works so easily?" Dr. Pena said it is used by some. The problem is that it is not specific and kills a lot of beneficial insects as well. [For this reason you should definitely use it only during that key time when the fruit is susceptible to infestation.] People also make traps out of vinegar, hydrolyzed protein or anything that will ferment, plus insecticide. This method is used mostly in greenhouse and research plots.

Is there a general rule that fibrous mangoes are less susceptible to insect damage? Not necessarily, but there are great varietal differences in insect susceptibility between fruits of many species, including mangoes. I always urge our readers to do some of their own experimenting. Plant a lot of mango seeds here and there and see what kind of fruit each yields. Perhaps you will come up with a superior mango that is even more resistant to the fruit fly! Carl is all for that, but said to

watch out for polyembryonic mangoes. If you are still interested after that big word, read on.

Chances are extremely high that the local fibrous mango is polyembryonic. This means that each seed contains not only the embryo that resulted from cross-fertilization (called a gametic embryo), but also several (nucellar) embryos that developed from the parent tree's own tissue, the nucellus. Several trees may emerge from the single seed, but one of the stronger nucellar ones are more likely to survive. This can be a benefit if you like the parent tree and want to start identical trees from seed. But if you want to start trees hoping that some will be better than the parent you are out of luck. You can tell if you have the polyembryonic type by removing the husk from the seed. You will find a lot of cotyledons curled around each other. If it is monoembryonic, you will find two big cotyledons and a single embryo. Trees coming from monoembryonic seed will have a combination of genes from

two parents, resulting in many different combinations of traits.

In summary, if you want to try to develop a better mango, get seed from as many sources as possible, and concentrate on monoembryonic seeds. (Citrus presents a similar situation. It would be a shame to plant 100 citrus trees hoping for a few superior ones only to find that all were polyembryonic and "came true" from seed.)

**MANGO TREES THAT DO NOT PRODUCE.** Jack Mahaney wrote us after visiting Gary Dawson in Venezuela. "While they have many large, mature mango trees, no fruit is borne. There are heavy crops at other stations within a hundred miles or less. What is needed in order to produce fruit?"

I called our standby for tropical fruit questions, Dr. Carl Campbell, who was familiar with the problem. The most common cause is a location where the trees bloom during

periods of high humidity and temperature. This leads to anthracnose infection of the flowers and no fruit set. It can be controlled by spraying with fungicides, such as those containing copper, carbamate (e.g. Maneb), or benylate. It is so humid in southern Florida that Florida growers are wiped out most years unless they spray. There are varieties from Southeast Asia that will do better under such conditions. He mentioned varieties Saigon, Florigon, Pico and Carabao.

It is very difficult to get tropical fruit trees shipped overseas. If you know someone who has the tree, can you have seed sent? The good news is that all of these varieties are polyembryonic and consequently most trees will be just like their parents. The bad news is that mango seeds are viable for only a couple weeks after removed from the seed and dried. I asked whether you could extend the life of the seed by wrapping it in wet paper towels. Carl explained that mold is a terrible problem with seeds stored this way. The best approach is to surface

sterilize the seed by dipping it in 10% chlorox, then pack it in barely moist (no free moisture should be visible) activated charcoal and ship in a plastic bag. (Might regular charcoal substitute for activated charcoal?)

There are locations where the trees do not even bloom. (Carl said you need to be alert because sometimes people have insisted their trees do not bloom, but more careful observers contradict them.) Fungicides will be no help there. For example, he has seen large areas in the Philippines where mangoes do not bloom. This appears to be due to the uniformity of high rainfall and temperature which does not permit the trees to have their normal dormancy. In 1972 scientists in the Philippines found that if they spray the leaves with as little as 10 g/liter of potassium nitrate, the buds will start elongating within 2-3 weeks and will bloom within a month. Spraying is done only once, but the trees are drenched completely. They time the spray to have bloom and fruit

growth during the least stressful season possible. Apparently it is effective only when the tree has attained a "ripeness to flower." Signs of this stage include: leaves become dull green or greenish brown and brittle when crushed with the hand and the tree has an appearance of suspended growth. Another use of this technique is to induce earlier flowering to beat the market and get higher prices for the mangoes. The fruiting season can be advanced several months in the Philippines.

INTRODUCING NATIVE FRUITS IN ZAIRE. Roy Danforth and Paul Noren, Zaire. "It was slow going at the beginning of our program as people used to refuse to plant fruit trees for reasons such as, 'I'll die before the tree starts fruiting' or 'if a man eats fruit, he'll get a hernia and have to be operated on' or 'fruit gives me diarrhea.' But now jakfruit, canistel, rollinia, black sapote, yellow passion fruit, abiu and inga are big favorites with the local people.

"We now have several hundred species of fruits, nuts and other useful trees/vines and have planted them out in various locations ranging from a single tree in someone's yard to several acres in an orchard. Some species have little potential to help the people here as they take too long to come into production or the fruit is not of good quality.

"However, we have hit upon several really good winners for this area. The top vote getter with the local people is the canistel (*Pouteria campechiana*-see drawing), simply because it is good food. Its taste is similar to the sweet potato that is widely grown and eaten here [Ed: except that canistel does not need to be cooked.] Rollinia (an *Annona*) is a close second as it is a large fruit with a lot of edible flesh.

"Jackfruit (*Artocarpus heterophyllus*) is becoming more and more popular. Though not everyone appreciates it, those that do cannot get enough of it. More jackfruit trees have been

planted than any other tree and many come into production in less than two years! Because they are seedlings, there is enough variation in fruit taste, consistency, latex content, etc. to find one that will please most everyone. ...The abiu is coming on strong as a popular fruit because the variety we are using has a short 2-year bearing age and produces large quantities of delicious fruit.

"A difficult problem here is thievery. These fruits are so popular that most of the fruit gets stolen off the trees before they are ripe. We get reports from everywhere that when villagers plant trees in their yards, the trees are dug up in the night and taken to who-knows-where.

"Other fruits that people continue to buy from the nursery include those that existed in the area before we started the agroforestry program. These include ambarella (*Spondias cytherea*), breadfruit, coconut, citrus, avocado and mango. Of



the last three it is the grafted trees that are selling. Of the native Zairian fruit trees, only one has been developed extensively and that is the safu or *Dacryodes edulis*. There are quite a few cultivars of this species that are much larger and less sour than the wild ones and they come nearly true to seed." You can order seeds from them on an exchange basis or pay equivalent to US\$1 for each tree type requested.

Roy Danforth, Paul Noren, and other missionaries with the Evangelical Covenant Church have, since 1978, worked with Zairian leaders in promoting programs such as agroforestry, animal husbandry, fish farming, appropriate technology, and rural development. If you want to visit them, fly Europe down to Bangui on a commercial airbus. Then take a small Caesna plane into NW Zaire and to the station near the town of Businga. One aspect of their work involves establishing "tree gardens" around villagers' homes to supply food, fiber, shelter, fuelwood, and other benefits of trees. They have a collection of

trees that amounts to over 500 different species (mostly fruit) that they have received from sources all over the world, including ECHO. They feel that exchanging seeds and information has been the key element in the success of their agroforestry program and hope that more people get involved in networking. They published a small book, *The Native Fruits of Zaire* (US\$25/copy), a free annual newsletter, and an agroforestry seed list (\$2). Roy and Paul can be contacted at B.P. 1377, Bangui, CENTRAL AFRICAN REPUBLIC. (In the US, the book is available from Roy's father, Mr. S.C. Danforth, 6934 Lake Tree Ln., Citrus Heights, CA 95621; phone 916/729-6934.)

## **Working with trees**

LIMIT FERTILIZER AFTER TRANSPLANTING TREES AND SHRUBS. [The following is adapted from the May 1993 issue of *The Avant Gardener*.] This has long been an accepted but

unproven rule. Now a study by Dr. Warren at the North Carolina State University "has shown that root growth decreases as the amount of nitrogen fertilizer is increased. Nitrogen apparently does not enhance regeneration of roots pruned during digging.

"Many studies have demonstrated that after root loss, growth is redistributed in favor of making new roots. Above-ground growth slows as nutrients are transferred to the roots. So it is a mistake to apply fertilizer in an attempt to stimulate top growth, since the plant's 'instinct' is to regenerate a full root system. NCSU experiments showed that replacing damaged roots is slowed at a rate directly correlated to the amount of nitrogen fertilizer used. This may negatively impact transplant survival and prolong the establishment period. Little or no nitrogen should be applied in the first year after transplanting."

ECHO asked Dr. Warren to clarify some points. Does this apply only when the plant has been dug up and root damage has occurred, or also when a plant is carefully transplanted from a pot into the soil? "I have no direct data, but I believe it applies to all transplanted material since establishment is still dependent upon generating new roots into surrounding soil." Do you mean to add no fertilizer or just no nitrogen fertilizer? "The data is only applicable to nitrogen fertilizer. I would make sure there are adequate levels of P and K. Recent information suggests that these two do not interfere with root growth."

WATERING CUPS USED IN PLANTING TREES. Joel Matthews in Niger wrote, "In experimenting with direct seeding and transplanting seedlings, I have found that a trench with 'watering cups' greatly increased survivability of new seedlings in hot, dry sun scorched areas." In an area where Joel wanted to make a living fence, he dug a narrow trench about 8 inches (20 cm) deep. At spots where a tree was to be planted, he

loosened the soil perhaps another 8 inches deep and made a slight depression for hand watering if needed. He calls these "watering cups."

"When preparing my living fence, I only did a portion as a trench; the others were in a slight depression. I direct seeded *Ziziphus mauritiaca* and *Z. spina christi* in mid May. After a 3 week moist period we had almost a full month without rain. The result-80% of the seedlings in the trench survived with periodic watering, whereas only 40% of the seedlings with watering cup only but no trench survived. My trial with no watering cups and no trench saw only about a 20% survival rate." Benefits cited include: lower soil temperature, greater moisture retention, wind protection, protection from animals, overhead shading possible (e.g. by placing corn stalks over the trench), water catchment, and improved microclimate. [Might birds be less likely to dig up seeds or pull up young seedlings?]

SUCCESSFUL METHOD OF TAKING FRUIT TREES FROM THE STATES TO ZAIRE. See above about Roy Danforth's large collection of tropical fruit trees. He collected many potted trees while in the States one winter. "In all I bare-rooted and bagged 315 trees, threw them into trunks and carried them for 4 1/2 days. I'm pleased to report that not one of them died in transport."

Here is Roy's procedure. (1) Shake the tree to remove most of the dirt from the roots. (2) Dip the roots in a bucket of clean water to rinse off the remaining dirt. (3) Spray the roots with a solution of 50% hydrogen peroxide and water, which releases oxygen for the plant to use in transit. (4) Shake off excess water, then slip a baggie [plastic sandwich bag] around the roots only and tie it tightly around the trunk. (5) Severely prune back [those trees which are too large for your suitcase], though do not remove leaves from what is left. Spray the leaves with an antitranspirant. [Roy used Poly-Trap, but there

are many on the market. They form a polymeric film around the leaves and reduce the loss of water by transpiration. They are used commercially to treat seedlings before setting them in the field to reduce shock.] (6) Use no medium, such as sphagnum moss, for the roots because it is unnecessary and causes a lot of fuss with the plant inspectors. (7) Do not place bags on the tops, as this will increase the possibility of rot. (8) Lay the trees in the trunk, making certain they will remain stationary by careful positioning and use of padding. "I was worried about the temperature during our overnight in Paris in February, but it apparently had no effect." Roy is generous in sharing seeds and cuttings. Write him at B.P. 1377, Bangui, CENTRAL AFRICAN REPUBLIC.

MUD DIP FOR ROOTS WHEN TRANSPLANTING. From Eddie Visser in Guatemala: "While transplanting citrus and leucaena seedlings into the ground, the soil would sometimes crumble off, leaving the roots of the transplant exposed. When this

happened we dipped the roots into a mud solution, so that the mud adhered to the roots. Almost all the transplants we did this to are still living. The ones we did not do this to died."

Timothy Volk with the Mennonite Central Committee in Nigeria wrote, "I noted Eddie Visser's comment on coating roots of seedlings with a mud solution. I recently was on a study tour in Togo and saw villagers doing the same thing. However, rather than using mud alone, they also mix in some cow manure and sand. We were able to see that the seedlings (leucaena mostly) did not dry out during the day and that earlier planted seedlings were doing very well despite a poor rainy season. In addition the manure provides a small amount of nutrients to promote early root growth."

TREE SPACING NUMBERS. How many trees would you need per hectare for a particular spacing between trees? The following comes from a booklet published in Colombia, Cmo



crecen los rboles.

<b>Distance Between Trees (in meters)</b>	<b>Trees per Hectare</b>
2.0 x 2.0	2,500
2.5 x 2.5	1,600
3.0 x 3.0	1,111
4.0 x 4.0	625

GROW SMALL FRUIT TREES IN CIRCLES. (Excerpted from an article on permaculture in India in the International Agricultural Development, April 1992.) "A novel idea has been to grow some fruit trees, like bananas and coconuts, in circles about 3 meters in diameter. Inside the circle a thick layer of humus builds up. Circle planting makes it easier to water the trees. When trees are planted in a line they have to be watered separately, but in a circle watering occurs once from the center. There is also less shading of adjacent crops."

**DANGER SIGNAL OF HEAVY FLOWERING.** Peter Storey wrote from England: "In EDN you mentioned the 'hopeful' sign that many neem trees are going through a period of heavy flowering. This is not a hopeful sign. Unusually heavy flowering in trees can be a sign that the tree is having one last fling. It will use up its carbohydrate reserves and may die the next season. One of the signs of citrus decline is heavy flowering which is followed by death of the tree in one or two years.

"When plants (trees in particular) have a higher proportion of carbohydrates than nitrogen, their regulatory mechanism senses that they have plenty of reserves to produce fruit and so produce many flowers. In the opposite case, when nitrogen is higher than normal, the plant produces more leaves so as to make more carbohydrates.

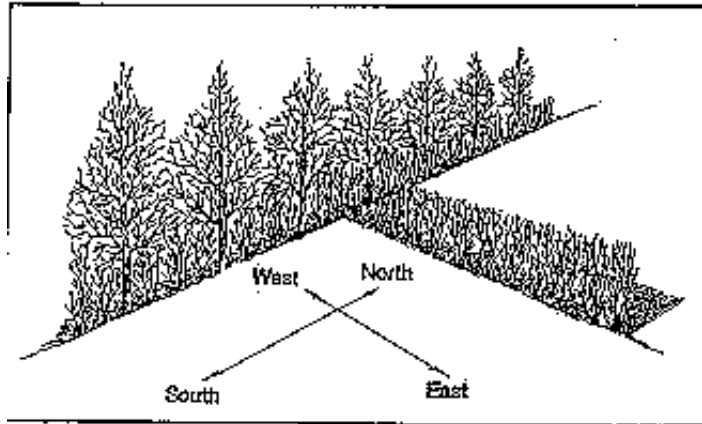
"When roots are damaged by disease or pruning, the plant is

less able to take up nitrogen and the ratio of carbohydrates to nitrogen increases. This is a signal to the plant that things are not so good and that it is likely to die. To ensure that it reproduces itself, it sends out a lot of flowers."

This reminds me of the technique of girdling used by some homeowners to bring fruit trees into earlier bearing. A complete circle is cut around the trunk wide enough to shock the tree but narrow enough that it eventually fills in and does not kill it.

"THE LIVING FENCE, ITS ROLE ON THE SMALL FARM," (6 pp.) by Dr. Frank Martin is a brief overview listing advantages and disadvantages of living fences. Five exceptionally useful living fence trees are briefly discussed. Finally, a 3-page table lists 66 species that have been used in living fences, their climatic adaptation, method of propagation, size, whether pruning is necessary, and other uses. Available from ECHO.

# HEDGES FOR RESOURCE-POOR LAND USERS IN DEVELOPING COUNTRIES



hedges for resource-poor land users

When we offered our small Technical Note on living fences (above), I asked whether anyone knew of a well-illustrated and carefully written book on the subject of living fences. Jrg Henninger in Paraguay told us about this book. He wrote, "Its 256 pages give orientation about techniques for establishing

and management of hedgerows, uses and functions, social and economic issues and a list of species applicable. It has about 57 tables and 92 figures. I love this book because it is by far the most complete one I know."

Now that I have the book, I can understand his enthusiasm. The book is exceptionally thorough, perhaps to a fault. (My personal preference is for a "get to the point" briefer style of writing.) I have selected a few highlights to give you a flavor of the book, and because the information itself is worthy of a note in EDN.

"Lac production on hedges can be an incentive for soil conservation." Shellac is made from the resinous secretion by the lac insects. Several host hedge species are listed, including acacias and pigeon pea *Cajanus cajan*. "In Thailand lac lice raised on pigeon peas planted on contour bunds for erosion control has been promoted by one project. Loss of cropping

area to the hedge row can be more than compensated by selling of stick lac and pigeon peas."

For many farmers the only option is a stockproof hedge without barbed wire. Such a hedge should be low- growing, sturdy, multi-stemmed from the base (or low branching), dense branching with rigid or entangling branches and a spreading crown, small, sparsely distributed leaves that cast little shade, have spines, prickles or thorns, be resistant to fire, trampling and browsing; require little upkeep; be capable of regeneration if damaged. Not many plants meet these characteristics. So often a mixture of plants are used to fill in the gaps and strengthen the barrier. The following categories can be distinguished: framework plants, fillers, and entanglers. Four pages with 15 tables list trees and shrubs (names only) with high potential for: food, forage, fuelwood, timber, soil conservation, ornamentals, fillers, irritants, entanglers, fence reinforcers, garden hedge, windbreak hedge,

general security hedge, live fence post, tropical highlands, humid tropics, arid & semi-arid tropics.

The weakness of the book, for development workers, is that you can read a great deal and still not have much of an idea as to what to do locally. I found the four brief case studies especially relevant, and wish there had been four hundred. Two case studies are summarized next.

Villagers in Huanca, Peru (3600 meters, temperate cold, 600 mm rainfall) developed this system after natural vegetation disappeared. Small fields are surrounded by a living fence of Cassia. Annual crops are grown followed by a fallow period in which animals graze in the fields. Just before planting the trees are coppiced, leaves used for mulch and wood dried for firewood. The Cassia has been growing 4 years and the cycle starts again. A study showed that Cassia (planted 1.5 m apart in the fence row) makes an average family self-sufficient in

their annual fuel requirement.

In arid watersheds, many flood plain farming communities have disappeared or shrunk because the land bases have been destroyed by flood. In contrast farmers in the upper Rio San Miguel have maintained a fairly stable agroecosystem. Use of living fences is a key reason.

Living fences are planted along the margins of the riverbank. Farming takes place on the floodplain. Flood water carries a heavy load of top soil from overgrazed rangeland upstream. As the flood begins to overflow into the space between the fencerows and the edge of the cultivated area, the force of the water is broken by the trees and by brush that is deliberately thrown in around their bases. (The brush also helps keeps cattle out.) The sediment load of the less rapidly moving water settles out behind the trees, fertilizing the fields. The fences also retard erosion and cutting of new channels. Eventually



enough alluvium is accumulated behind the fencerows that cultivation can be extended right up to the row of trees [elevation is increased].

To make hedgerows, cuttings are taken from *Populus fremontii* (a cottonwood tree) and *Salix gooddingii* (a willow). Brush from various local species is woven between these vertical posts. Cuttings (3-4 m) are trimmed from all branches and leaves and planted in trenches (1.5x0.5x0.5 m) at a planting distance of 0.5-0.75 m. One cottonwood is planted between a dozen willows. Mature trees in older fencerows are pruned so that the trunk is about 2 meters.

The book was published by the GTZ, which will often send a book at no charge to a non-profit development group working in the developing world. You might write on official letterhead to see if you qualify. The address is GTZ; Postfach 5180; D-65726 Eschborn; GERMANY; fax 06196-797352. Those who do

not qualify for a free copy can order for about US\$26 plus postage from Margraf Verlag, P.O. Box 105, 97985 Weikersheim, GERMANY; fax 49-(0)7934-8156.

THE ITTO TROPICAL FOREST UPDATE is published quarterly in English, French, and Spanish by the International Tropical Timber Organization as a forum for information exchange on aspects of sustainable tropical forestry. This resource can keep you up-to-date on courses and current literature, make contacts working in your area, and give information on organizations and topics on forest management. The March 1996 issue featured fire in tropical forests around the world, production and trade of tropical logs, a country profile of Bolivia, details of upcoming seminars, and several pages of input from readers. This newsletter is free from the Editor, ITTO Tropical Forest Update, ITTO Secretariat, International Organizations Center-5th Floor, Pacifico-Yokohama, 1-1- 1, Minato-Mirai, Nishi-ku, Yokohama 220, JAPAN; phone 81-45-

223 1110; fax 81-45-223-1111; e-mail asarre@itto.or.jp.

