

## CHAPTER 12:

# *SEEDS AND GERMPLASM*

Many people's first thought about ECHO is "seeds." Our seedbank specializes in little-known plants with great potential to provide food under difficult growing conditions. We also have several improved varieties of common plants. Each year we distribute hundreds of trial seed packets to development workers who grow them in their own gardens. If the plants produce well and are accepted, they may harvest the seed and distribute it in the community. In this way, a community in one part of the world may benefit from the plants of another region to which they might otherwise not have access.

Plant introduction through seeds and germplasm (living tissue that can be grown into a plant) holds tremendous promise for improving nutrition and food production. This book contains information on many such plants which can thrive in poor soils, drought, and other stresses. There are also dangers and risks in plant introduction about which we need to be aware. This chapter discusses working with underexploited plants, seeds and other germplasm, and seed production and sources.

## CHAPTER 12: SEEDS AND GERMPLASM

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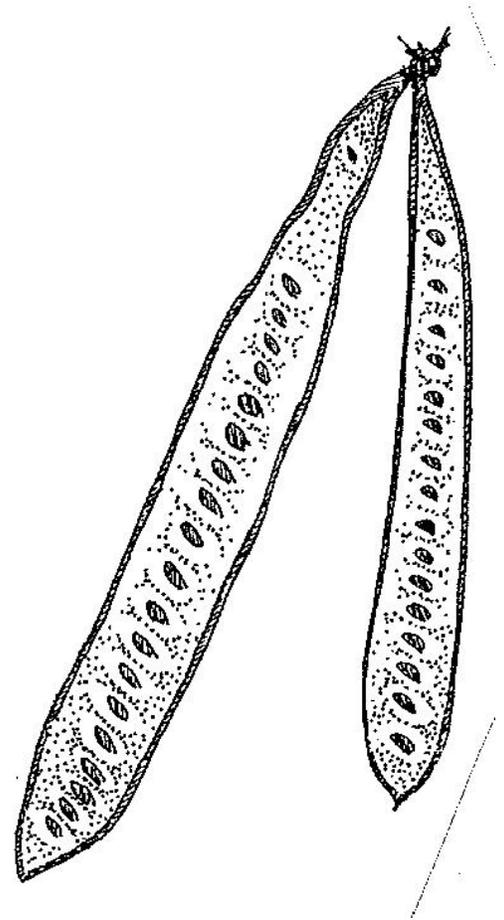
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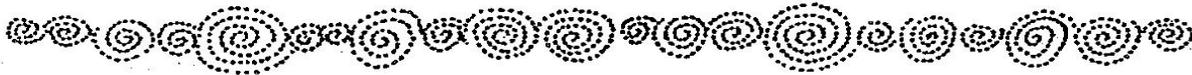
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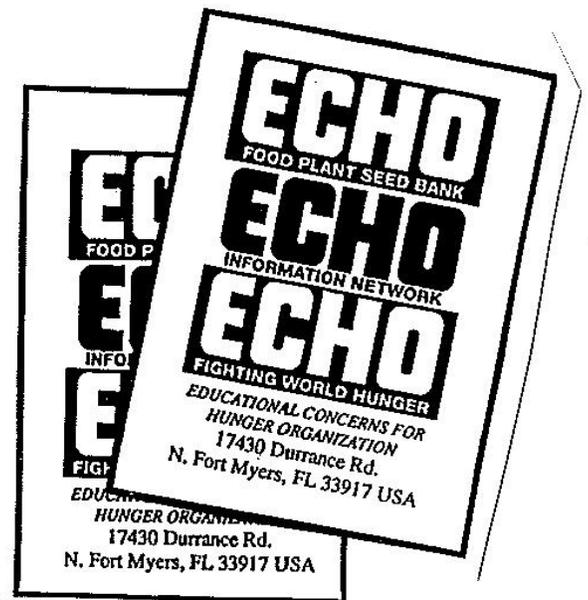
## ECHO'S SEEDBANK

**ORDERING SEEDS FROM ECHO.** Only people who work overseas helping small farmers should write for free trial seed packets from ECHO; those who qualify include overseas missionaries, development workers, extension agents, and scientists. People who do not qualify for free trial seed packets include individual farmers anywhere in the world, home gardeners in North America and Europe, and others who do not work directly to benefit small farmers. Those not involved in development work must pay US\$2.50 per packet of seeds, postage included. People overseas should write ECHO for a current seed catalog, which is updated periodically. (Those in North America may purchase our descriptive catalog of selected seeds appropriate for outside the tropics; cost is \$1 plus \$1 postage.)

**HISTORY AND PURPOSE OF ECHO'S SEEDBANK.** The seedbank was begun in response to the National Academy of Sciences book *Underexploited Tropical Plants with Promising Economic Value* (1975), which described 36 plants selected as among the most promising plants for tropical regions. Unfortunately, at the time (and even today) there were few accessible sources for seeds or cuttings of these plants. Few scientists and research institutions were able to supply seed for these plants. ECHO was convinced of the tremendous benefit from putting seeds for these plants into your hands, so our seedbank was established for this purpose.

ECHO's seedbank began in 1981 with the top recommendations of tropical plant specialist Dr. Frank Martin--quail grass, amaranths, tropical pumpkins, lablab beans, tropical lettuce, and more. In 1996 our seedbank holds over 1200 accessions, and we actively maintain and distribute about 125 of these. We grow out most accessions to produce seed on ECHO's farm in Florida; we purchase others which will not grow on our site or for reasons of seed purity or disease we choose to obtain from another source. We do not carry seeds of many staple crops, as there are large organizations committed to research and improvement of these crops. We do not supply common vegetable or fruit seeds, which are commercially available through seed catalogs.

Our seedbank is a central part of ECHO's work. Though these plants are exciting, how much of your effort should go into working with them? Given the frequent difficulty in introducing a new food to a culture, it would most likely be unwise for you to make introduction of these promising but unusual plants a cornerstone of your work. You need to make an immediate impact on your community. Probably you have found some things that do this with little risk. Furthermore, people usually expect project results within a few years. A project to get winged beans, for example, widely accepted in your country would not be likely to succeed in that short time.



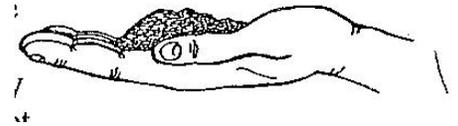
We believe that working with PVOs presents an ideal way to introduce such plants however. Why? Because you or your organization have made a long-term commitment to your region and can see the long-term possibilities. What is unlikely in 3 years becomes possible in 10 or 30 years. We are just as concerned with the people who will be living there in 30 years as we are for those today--and they may use winged beans as a staple! For example, the potato was introduced to Rwanda by European missionaries in the early 1900s. The people would not eat it. Today it has become a staple and 45,000 hectares are grown.

The cost of trying a few of these special plants is almost nothing. I cannot think of many things which can have such an impact in the long term at such a small cost today. Initial acceptance will probably come as a crop to be consumed by the farmer, with cash crop possibilities coming much later if at all. Do not feel embarrassed if you cannot report back to us that the masses are now growing the crop. Such reports are rare. If something catches on in 10 years, do not forget about us! We would be greatly encouraged to hear about it.

When you consider which "new" plants you want to try from ECHO's seedbank, it is often good to start with something which can be easily incorporated into the local diet. For example, while West Africans who eat a variety of leaves may readily accept a new leafy vegetable, a community in Latin America which considers leaves as animal food may not accept the same plant, no matter how tasty your recipes. People who eat soups often readily add a new plant to the soup pot. Watch for local cooking techniques which can be used with other plants. Be prepared for surprises, too: people in the community may find the new plants appealing for their novelty value, as occurred with rhubarb in highland Ecuador. Quail grass from ECHO spread rapidly through a village in Panama in part because people appreciated its colorful and ornamental appearance.

**THE NATURE OF PLANT INTRODUCTION: SOME IMPORTANT CAUTIONS.** ECHO supplies small seed packets for trial. It is important to understand that the plants must be treated at first as experimental before making recommendations to members of your community. Many, many development workers have introduced and promoted "miracle technologies" and "wonder plants" before giving them adequate trial and experimentation on site. Not even studies in the same country can guarantee acceptance or success. Hasty introductions of new ideas or plants are likely to encounter serious problems. Farmers may have planted their fields with the new varieties or invested their savings in the new tool when the problems surface; perhaps a pest or disease strikes, or the equipment is faulty or unsuitable. In the end, farming families will suffer, and the development worker will understandably have a *very* difficult time promoting any further ideas or innovations. People may lose confidence or trust, with serious consequences for your work or ministry.

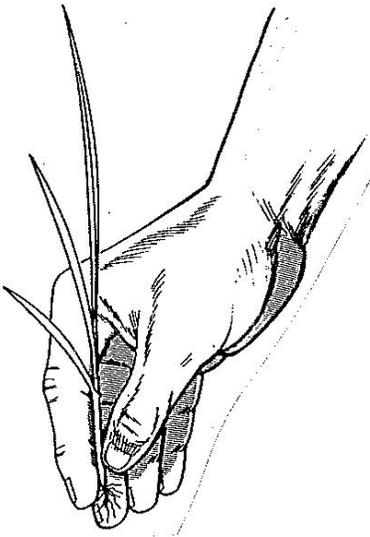
There are many advantages to conducting your own trials before disseminating seeds in the wider community. It is important to know whether the plant can grow in your area before farmers devote land and time to cultivating it. Through conducting trials you may find the best "window" in your seasons for the optimal performance. You receive only a small packet of seeds from ECHO; if the plants produce well, you will have plenty of seeds to share. If the plants do not grow and produce seed, perhaps they are not suited to your region. Should the species be enthusiastically accepted, ECHO can refer you to commercial sources for some seeds if you need larger quantities or want to broaden the genetic base. If the plant holds great promise in your area, it is best to obtain more seeds from another source before the planting areas become too large. Genetic diversity not only offers potential for superior plants to be identified, but also affords protection in case of disease outbreak. (See the discussion of the Small Farm Resource Development Project in the first chapter for more about conducting trials.)



Beyond avoiding the risk of total planting failure, small trials allow you to evaluate the "weed potential" of certain species in your area. Watch the planting carefully the first few seasons to make sure it is not likely to become a problem plant. Unfortunately, one definition of a weed, "plants which thrive under stressed conditions, often with high seed production," fits some of the plants in ECHO's seedbank. We are very aware of this risk and have in fact eliminated certain species from our seedbank when the danger of introducing a weed seemed too great. However, hardy plants which can establish themselves may be a great blessing in many situations; for example, it is difficult to imagine a tree which could become a pest in certain areas of Africa or Haiti with severe fuelwood shortages. Sending out only small trial packets of seed is another safeguard against introducing a weed, as too-aggressive plants may be identified and controlled easily in a small area. Finally, remember that the plants in ECHO's seedbank are commonly accepted food plants somewhere in the world, even if very localized. In this, too, there is a measure of safety as we can all learn and benefit from the years of plant selection by people in other parts of the world.

ECHO's seedbank is very small. We do not guarantee the seed count in each package, the viability may sometimes be low, and there may only be a small number of seeds in your packet if our supplies are limited and demand is great. We cannot supply quantities of seed for routine production. Rather, we expect you to increase your own seed if the performance of the plant warrants this. Sometimes we may send more than one variety of a requested seed, so that you may determine which of these gives superior performance in your region.

In all cases, we look upon those who request seed as collaborators with us in field trials. This does not mean that you must do elaborate experimentation, but we do expect you to take time to write to us after the food has been harvested, letting us know your general impressions on its suitability to the region and the culture. A **seed trial report** form (in English, French, or Spanish) is sent along with your seeds. We enter your results in our database and use this information to make more refined recommendations to others and to share with interested scientists. These reports are very important to us, to be aware of germination or weediness problems, as well as to learn of successful introductions and acceptance of the plant in the community. We are always glad to receive the seed trial reports, but we also have special interest in longer-term results of plant introductions and the effects of ECHO's work. If you receive seed from ECHO and the plants are adopted in the fields and gardens in your area, please let us know.

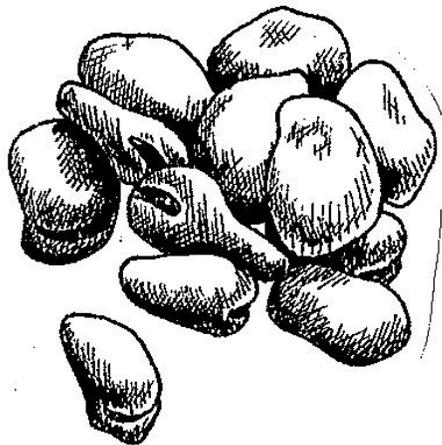


**TRANSPORTING SEEDS AND CUTTINGS.** We should all be aware of the danger of inadvertently introducing a new pest or disease to an area along with a new plant. This is a serious concern, and it is one of the reasons we do not distribute major cereal grains or commercially important crops. Many pest outbreaks (the cassava mealybug in Africa and hundreds more such cases) have occurred when someone carried an infected/infested plant to a new area which lacked the natural predators or controls of the pest's native habitat. We do not send seeds known or suspected to carry such problems. All of our seeds are treated with fungicide and insecticide to minimize this risk. You should also keep a close watch on new plants for pests and diseases, and let us know of any problems you experience.

ECHO will send you the seeds you order, treated as described above. You are responsible for the seeds upon arrival. The next time you are in the capital city of your country, you might inquire about any special procedures for importing seed, then send us any required forms with your order. (If your plant import permit requires a phytosanitary certificate, the certificates are issued by a government plant inspector certifying that he/she has visited the farm, seen the plant material and that it is free of disease and insects. These are most likely going to be required for shipments of live plants or cuttings. We must pay the inspector \$20 for the certificate, so please enclose that amount with any order requiring it.)

Like many universities, ECHO has an "unofficial" phytosanitary certificate in which we certify that, to the best of our knowledge, seed came from disease-free and insect-free plants and that the seeds have been treated with insecticide and fungicide. If requested, we enclose this with seed orders large enough to require a package. If you believe this certificate would be helpful you can request that we enclose it. However, it will not be enough with higher-risk imports, such as cuttings or roots of sweet potatoes, and certainly will not suffice if your import permit requires an official phytosanitary certificate.

**WHEN YOU SEND SEED TO ECHO.** Our seedbank has been greatly enriched by seeds sent by overseas members of ECHO's network. If you have seeds to share, write first telling why you think we might be interested and giving as much information as you can. If it is a seed that we could use, we will send a green and yellow mailing label (a plant import permit) issued in our name by the Department of Agriculture. All you need to do then is put the seeds in a package, identify each packet, and use the permit as your mailing label. The seeds will be forwarded to us after inspection.



When you send seed to ECHO, please treat it with a modest amount of insecticide. Please do not cover the seeds in quantities of powders; our customs inspectors do not appreciate that, and they may dispose of overtreated seed. We do need to be careful about pests. Years ago, there were two containers of seed sitting on my desk, each with a different type of adult insect pest crawling all over them, both sent to us from overseas. Fortunately the containers were well sealed and I was able to destroy the pests promptly. In another instance I was not so fortunate. I had a bouquet of a dozen dried sorghum heads in a vase, each a different type from Purdue University's International Sorghum Variety Trial, which I had cherished for twelve years. Someone sent an envelope of corn from overseas, and it was left in my office for a few weeks. One day I noticed that small insects had emerged from the seeds inside the envelope. I immediately put the envelope in the freezer to kill the insects, and I disposed of the grain. A few weeks later, however, the same insect was discovered destroying my sorghum bouquet; by that time, it was too late to save the bouquet, and it had to be discarded as well.

A related issue: please do not send infested seed or a diseased leaf or soil in an envelope for us to identify. ECHO does not have an entomologist on staff, and we cannot have your problem getting loose at ECHO! If it is important to know what the insect is and you cannot find someone in country to identify it, you might be able to send it in alcohol. Be sure it is in a very sturdy and tightly sealed container. However, a description might be sufficient. In most cases, precise identification is not important. Given the lack of resources available in most peasant farming situations, it is usually enough, for example, to know that it is some kind of caterpillar or some kind of grain weevil. The low-technology options for control that are available are probably generic caterpillar controls or generic weevil controls anyway.

**GETTING YOUR OWN SEED IMPORT PERMIT.** It is easy for U.S. citizens to obtain their own permit. Permits are designed for mailing seeds to the States, but usually help get you through customs with modest amounts of permitted seeds that you are carrying with you. Some plants are not allowed entry, especially those listed as "noxious weeds." It might also be more difficult (and dangerous) to bring seeds of crops of major economic importance in the States. The inspector probably would not let you bring citrus or corn because of the economic damage that could be done by introduction of a new disease or pest. Permits can be easily obtained by any citizen by writing to Permit Unit, USDA, APHIS, PPQ, 4700 River Rd., Unit 136, Riverdale, MD 20737, USA; phone 301/734-8645; fax 301/734-5786. The USDA must first send you a formal application, so allow plenty of time for two exchanges by mail. Permits are good only for the particular port of entry that you specify (so ECHO's Miami permit cannot be used in New York). For living plants, you also need a post-entry quarantine permit and a place (it could be a residence) where the plant will be kept and federally inspected for two years.

## STORING SEED

**ECHO'S SEEDBANK HAS FOIL-LINED SEED PACKAGES.** The lengthy trip in the mail and, sometimes, time sitting on your shelf waiting for the rainy season, is hard on seeds. The two best ways to increase the life of seeds are to reduce moisture and temperature. The foil in our seed packages forms a moisture barrier. Each seed lot is dried and treated with insecticide and fungicide. Seeds are measured into labelled packets, which are sealed with a quick brush of an iron (like those used to iron clothes). If you can put the sealed packets in a refrigerator you should have a much improved chance of good germination. You can reseal them with an iron if you wish.

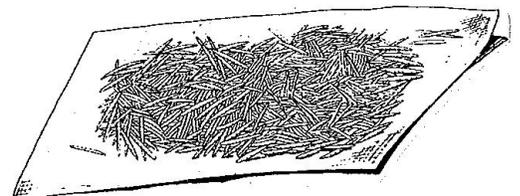
**BASIC SEED HARVEST GUIDELINES FROM ECHO'S SEEDBANK.** For plants with seeds that mature and dry on the plant, like corn, beans, amaranth, millet, sorghum, peas, lettuce, tarwi, kaniwa, etc.: Only harvest fully mature seed. The plant may start to die before the seed is ready. Harvest seed when dry (not wet with morning dew or after a rain). A good guide is when the first seeds are exposed or shatter (fall to the ground), as with the grains, or when pods are brown and crisp, for beans. (Amaranth can be a difficult plant to harvest--keep a close eye on it so you don't miss the seeds and lose them as they fall; you may even need to "milk" the seed clusters a few times to get the seed as it matures.) To avoid bean borers and fungal problems, however, it is best to harvest continuously toward the end of the season, so mature seeds do not stay in the garden too long. Many of these seeds can simply be threshed or shelled and cleaned from debris by winnowing with the wind or a fan.

For plants with fleshy fruits, like gourds, squashes, pumpkins, and peppers: Be patient. Only harvest fully mature fruits. The plant may be completely dead by the time the seed is ready for harvest. Remove fruits from plants and allow them to get soft, past the point you would want to eat them (except pumpkins, which do not soften, but do ripen during a few months after removal from the vine). Seeds are perfect for harvest if they separate easily from the flesh when rubbed out under water, for example. Scoop all the seeds and flesh into a large bowl or bucket of water, and work the seeds free with your fingers. Healthy, mature seeds will usually sink, although if all the floating seeds look better than those sinking, the case may be reversed for your plant. (Sometimes, good pumpkin seeds may float, while dead ones sink. Many cucurbit seeds, among others, have a 'dormant' period after harvest, so wait a few months to test the germination. In one case, freshly harvested, dried pumpkin seeds had zero germination, but another test several months later had over 80% germination.) This makes it very easy to clean the seed: simply rub the flesh away from the seeds, and tip the dirty water and flesh off the top; add more water, swirl the bowl, and pour off that water; continue for a few more washes until only the seed is left at the bottom; strain and dry immediately. Please note that seeds should not be left in the water for a long time, as they may absorb water, swell, and start to germinate. Some seeds benefit from a period of "fermenting" in the water before cleaning the seeds from the fruits; in tomato, for example, this treatment is said to reduce some of the diseases which can affect the seedling during germination.

**SURFACE CLEANING.** Seeds are treated in an antibiotic solution (10% bleach is good) for 2 minutes. This eliminates much of the bacteria or fungi from the seed surface. (Vinegar has some antibiotic action. If that is all you have available you might wish to experiment on a small scale to determine how much you could use without reducing viability. I do not know how effective this would be.) Seeds are then washed in clean water.

**DRYING.** Be sure seeds are completely dry before storage. (Fruit seeds are exceptions to this rule, as many do not survive drying; see below.) This is best accomplished slowly and gently; after threshing or cleaning, allow most seeds about a week in a very dry place for this process to be complete.

Some basic principles to keep in mind: Once a seed is dry, it is best to keep it dry, even if that means leaving some chaff in with the seed or leaving a bit of dried "skin" on the seed. Do not re-moisten seed once it has begun to dry. Internal moisture is more damaging to seeds in storage than heat. Your seed may dry adequately simply by spreading it out on a screen in the sun for a day or two; avoid oven-drying, as it is often too fast or hot and can kill the seeds. Temperatures over 96°F can damage seeds. Stir drying seeds once a day to ensure even drying. Dry seeds break rather than bend and shatter when hit with a hammer. Then store the seeds in airtight containers with proper labels identifying the seed and date of harvest. Store in a cool, dry place if that is available. The humidity is the most critical factor; seeds can live in hot, dry deserts for much longer than in a cool but damp environment.



The bean seedbank at CIAT in Colombia places dry seeds in a chamber containing a desiccant to reduce moisture below 10%. This has probably been achieved if the color indicator on the desiccant has not changed over a period of about 5 days with the seeds present. In the past, we adapted this procedure, placing dried seeds in a small open container on top of some Drierite in the bottom of a large-mouth peanut butter jar with the lid tightly closed. We mixed a small amount of the more expensive colored indicator with the inexpensive white Drierite. If the blue turned to pink in only a couple days, we replace the Drierite. Once it remained blue for nearly a week we assumed that moisture content of the seeds was below 10%. If you cannot purchase Drierite or other desiccant, *Organic Gardening*

magazine says that you can use an equal volume of powdered milk (perhaps with a few crystals of indicator desiccant thrown in?). Desiccant (or milk, rice, etc.) can be rejuvenated by heating for a time in an oven at a low temperature. You may be able to locate some kind of desiccant at a nearby medical clinic.



**RULES OF THUMB FOR SEED STORAGE CONDITIONS.** We contacted two knowledgeable seed experts for details. Bob Heisey with Peto Seed Company, a supplier to the major retail seed catalogs, said that if saving seed for only a few years (not for decades, as in projects to preserve rare varieties), you can use this rule of thumb to store on open shelving in an air-conditioned room: the temperature in Fahrenheit plus the relative humidity should be less than 100. For example, if I can afford to keep a room at 70°F I would need to get the relative humidity to 30 or lower. [For those who have forgotten the formula, you can convert Centigrade to Fahrenheit as follows:  $F = 9/5 C + 32$ .] If the humidity of the entire room cannot be lowered that far, you can store seed in airtight containers together with a desiccant to absorb excess moisture. Effective

desiccants include charcoal, powdered milk, rice or other material which you have noticed absorbs water. The desiccant should first be dried at very low setting in an oven.

Ron Hurov, a botanist formerly in the seed business, believes that this rule of thumb is not adequate. He says that the main objective in storing seed is to reduce respiration. This is accomplished in three ways; adjusting temperature, humidity, and oxygen levels where seeds are located. **Temperature:** All seeds should be stored just above freezing level (34-35°C). An inexpensive walk-in unit or commercial refrigerator is sufficient. **Humidity:** Through Ron's experience, he has characterized seed into three areas: wet, semi-wet, and dry. The rule of thumb here is to copy a plant's natural environment. If the plant likes it wet, such as the botanical family Araceae, then store the seeds in water. A semi-wet example would be the Citrus family. A plant family stored in dry conditions is Leguminosae. **Oxygen:** Seeds should be kept in airtight containers free of oxygen. Vacuum sealing is ideal. A cheap (\$150) vacuum sealer/dryer can be purchased through a health food company. The best suggestion for an airtight container is a mason jar. Ziploc bags and other plastic containers are not good enough.

**THE COMMUNITY SEEDBANK KIT.** Millions of people have been fed by the higher yields as farmers switched to new "green revolution" varieties. But what happens to all those varieties that farmers used to grow? Some of them are the result of plant selection through centuries. "The introduction of modern grain varieties in the Mid East has led to widespread losses of traditional varieties. African rice is nearly extinct in its native homelands. ...a variety called IR-36 now extends over 60% of the rice lands of Southeast Asia where, only a few years ago, thousands of farmer varieties were common. ...the black beauty egg plant is ... destroying its own diversity in the Sudan."



These lost varieties may have traits that would be invaluable if, for example, a new disease strikes. One of those varieties might be much better adapted to difficult growing conditions in another part of the country that wishes to begin growing the crop. They will also be invaluable to producing future "green revolution" crops. This loss of genetic diversity is of equal concern to the small farmer, the international center and the big seed company.

The purpose of the *Community Seedbank Kit* is to help private volunteer agencies develop community seedbanks to collect, preserve and assure easy community availability of seeds of crops in their region before further "genetic erosion" takes place. The kit is not a book. Rather, it is a loose collection of several 4-15 page sections. Topics include: Building the bank (the need); Building the bank (practical); The role of the voluntary agency; Sources and resources; Overview and issues.

The section on building the bank (practical) discusses how to select the crops to be collected, timing the collection, the

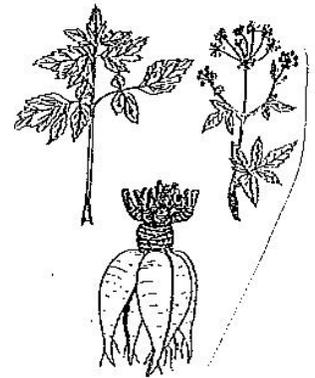
collection strategy once you are in the field, documentation, seed cleaning and drying, seed storage, collection grow-outs and a table indicating whether a seed is self- or cross-pollinated and its relative storability index.

If you can envision your organization undertaking such a project, the kit will be a great help. They anticipate future revisions. If those include some case studies and greater detail on practical techniques such as testing seed viability and appropriate technology alternatives to seed drying and storage, the kit will be even more helpful. The price is \$4.50 in North America, or \$8.50 (including airmail) elsewhere. Indicate whether you prefer English, French or Spanish. Order from Rural Advancement Foundation International (RAFI-USA), P.O. Box 655, Pittsboro, NC 27312; phone 919/542-1396.

**LOST CROPS OF THE INCAS.** The National Research Council of the U.S. National Academy of Sciences produced this book, and it is one of their best in the underexploited plants series. This series opened for me the world of plants that God has given to humanity which are still used in only a few countries and are little known elsewhere. This series ultimately led ECHO to establish our seedbank of underexploited plants. If you write to ECHO for information on any of the Andean crops, we will probably turn here first to answer your questions.

This book, written under the leadership of Dr. Noel Vietmeyer and a panel of experts, takes a close look at the wealth of plants native to the Andes mountains of South America. The region that gave us the pepper and potato has a lot more yet to offer. All together, 31 little-known fruits, nuts, grains, legumes, vegetables, and root crops are described in some detail. A chapter is devoted to each plant and includes a general introduction; prospects for the crop in the Andes, other developing countries, and industrialized regions; the plant's uses, nutrition, agronomy, harvesting, and limitations; and research needs. Chapters end with a short synopsis useful for people interested in growing the plant. Each chapter is well-illustrated with several photographs and drawings. The book provides an introduction to and stimulates interest in these crops, providing a valuable overview.

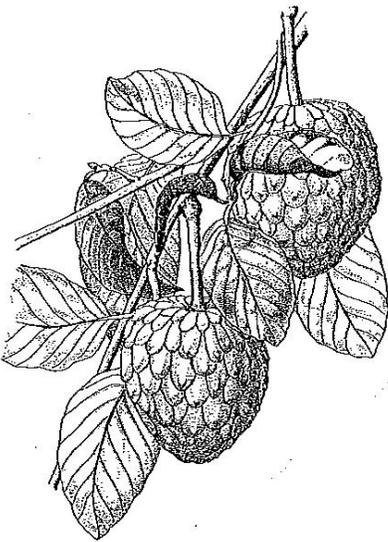
With the notable exceptions of the pepper and potato, Andean crops are seldom seen outside their native habitat. This is surprising in light of the wealth of crops that were developed over the centuries under the extremes of soil, rainfall, and temperatures of the Incas' vast empire. Many of the crops are quite nutritious and have only recently attracted the attention of researchers, but have the potential for worldwide usefulness.



Root crops include: achira (*Canna edulis*), containing a starch with unusually large grains; ahipa (*Pachyrhizus ahipa*), a legume whose sweet roots remain crunchy even after cooking; arracacha (*Arracacia xanthorrhiza*, pictured), carrot-like roots that can be boiled as a table vegetable; maca (*Lepidium meyenii*), a sweet, tangy delicacy in the highlands; mashua (*Tropaeolum tuberosum*), a staple that requires little labor; mauka (*Mirabilis expansa*), a "cassava of the highlands" that turns sweet after lying in the sun; oca (*Oxalis tuberosa*), a very hardy staple; little known potatoes (*Solanum* sp.) that have potential as germplasm; ulluco (*Ullucus tuberosus*), a brightly colored source of carbohydrates; and yacón (*Polymnia sonchifolia*), a sweet, yet almost calorie-free tuber.

Legumes detailed in the book include: basul (*Erythrina edulis*), a tree with large edible seeds; nuñas or popping beans (*Phaseolus vulgaris*), which are popped rather than boiled and make a tasty snack; and tarwi (*Lupinus mutabilis*), a lupine richer in protein than beans and peanuts with as much oil as soybeans. Vegetables include lesser-known peppers (*Capsicum* sp.) and squashes (*Cucurbita* sp.).

Several fruits have particular promise, especially in specialty markets: unusual or large berries (*Vaccinium* sp., *Myrtus* sp., and *Rubus* sp.); capuli cherries (*Prunus capuli*), a popular city tree; cherimoya (*Annona cherimola*, pictured), a delicious fruit grown commercially in the Mediterranean; goldenberries (*Physalis peruviana*), a very flavorful jam berry; highland papayas (*Carica* sp.), which have potential as germplasm; lucuma (*Pouteria lucuma*), a staple fruit which bears year round; naranjilla (*Solanum quitoense*), a good fruit for juices; pacay (*Inga* sp.), a sweet-fleshed pod; passion fruit (*Passiflora* sp.) that are superior to most commonly known cultivars; pepino (*Solanum muricatum*), a prospect for premium fruit; and tamarillo (*Cyphomandra betacea*), a popular juice fruit.



Three grains were also researched: kaniwa (*Chenopodium pallidicaule*), a nutritious grain with 16-19% protein; kiwicha (*Amaranthus caudatus*), with good quality protein high in lysine; and quinoa (*Chenopodium quinoa*), a better-known protein source. Two nuts are listed as well: Quito palm (*Parajubaea cocoides*), a high producer of tiny coconuts; and walnuts (*Juglans neotropica*), a fast-growing tree with good quality nuts.

It is particularly difficult for ECHO to keep seed in our seedbank of Andean crops, as most of them do not produce seed in Florida. With some exceptions, high altitude crops are the most difficult in the world for us to propagate. Between

Florida's normal seasons and our "semi-arid" and "rain forest" greenhouses, we can duplicate many climates. Duplicating a very long but cool growing season is our greatest challenge. If you work in the Andes and would be willing to supply us with seed for crops, ask for our "Andean seeds wish list" and we will send you a plant import permit.

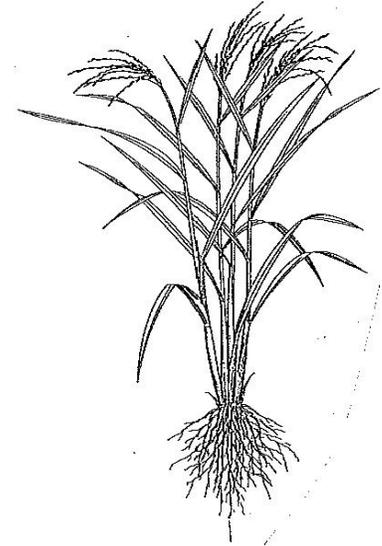
The book (415 pp.) is being reprinted with color photocopies by Craig Dremann at Redwood City Seed Co., Box 361, Redwood City, CA 94064, USA; phone 415/325-7333. Cost is \$40 including surface mail. For airmail add: Americas, \$12; Europe, \$16; Pacific Rim, \$20. His home page is <http://www.Batnet.Com/rwc-feed/>.

**LOST CROPS OF AFRICA. VOLUME 1: GRAINS** (383 pp.) is the newest in the National Academy of Sciences series on very promising but little-known or neglected species. Writing was funded by USAID. This inspiring volume (the first of three which are planned) discusses the potential of African grains for producing food and other products in Africa and around the world.

The series is "intended as a tool for economic development" among those who may promote these crops for local cultivation, develop markets for the grains, and explore the multiple uses of these species. The species discussed in this series were selected from nominations by people around the world. The information given about the crops helps readers to understand and appreciate the unique value of each plant and evaluate its potential for a given area. There are also very insightful appendixes on "potential breakthroughs" in some of the most pressing problems for development workers, including grain handling and child nutrition.



The species covered include: African rice, finger millet, fonio (acha), pearl millets, sorghums (subsistence, commercial, specialty, and fuel and utility types), tef, other cultivated grains (guinea millet, emmer, irregular barley, and Ethiopian oats), and wild grains. These plants offer much promise because they tolerate many extreme growing conditions and produce well with minimal inputs. They are generally nutritious and offer new flavors. They also offer other benefits; for example, the "fuel and utility sorghums" are used as firewood, liquid fuels, soil reclamation, wind erosion protection, weed control, crop support, fibers, brooms, and animal feeds. As with all the NAS books, further reading and many research contacts are given for each crop.



Readers in Western countries can purchase the book for \$24.95 plus \$4.00 surface postage and handling. Noel Vietmeyer and Mark Dafforn with the National Research Council told us they can think of no group more likely to make use of this book than those of you in ECHO's network who work in Africa. So they will donate enough books to send you a free copy while our supply lasts. IF you are already a member of ECHO's overseas network working in any third world country you may request one free copy of the book by writing clearly the address where the book is to be sent and enclosing postage if your work is not in Africa. For addresses **in Africa only** ECHO will pay surface postage. For all others (and in Africa if you want airmail) please send appropriate postage: surface \$4; airmail Latin America, \$6.00; airmail Europe, \$11.00; airmail Africa and Asia, \$11.70. MasterCard and Visa or checks in US dollars written on a US bank are the only payments we can accept.



## GERMINATION AND PROPAGATION

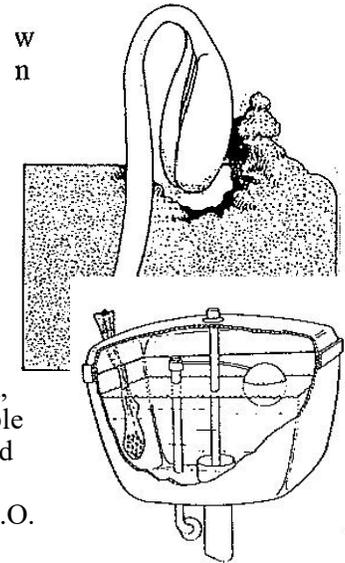
**MEASURING THE VIABILITY OF YOUR SEEDS.** It is a good idea to check the viability of your seeds before planting time. If the percent that germinate is low, you will know to plant a larger number of seeds. It is very important to test the germination of seeds that you have stored, and old garden seeds that have been given to your project. Local farmers can be seriously hurt if they rely on those seeds when the critical planting time comes, only to find that they germinate poorly or not at all.

We used this method to check the seeds in our seedbank. Remove a representative sample (do not select the biggest seeds) of 20 seeds or more from the container and **label it**. (The sample size depends on how many seeds are available. The larger the sample, the more reliable the results.) Soak the sample in 10% bleach for two minutes, then drain and rinse with water. Distribute the seeds on a clean damp paper or cloth towel and roll it carefully into a long cylinder. Enclose it in a plastic bag and store it in a warm damp place. Label each roll. Record the number of seeds that have germinated each day or two. Remove those that germinate, and replace the roll until the next inspection. Remember that seeds vary widely in the time it takes to germinate. Some germinate in 3 days, while others take 3 weeks or even longer for many fruit seeds. (Once we had a vegetable ivory palm come up from a seed that we had planted 16 months earlier!) Finally, calculate the percent that have germinated.

David Knight in Zaire asked, "Why is it necessary to count the germination on each of several days?" There are two criteria for good seed that the viability test measures: how many will germinate and how uniformly they will germinate. Sometimes a few seeds in a package will germinate quickly, followed by a few each day for several days. For example, winged beans often have non-uniform germination rates. Some kind of fruit tree seeds can do this to an extreme. It is helpful to know what to expect so you will know to keep watering. If you only want to know the percent that will germinate eventually, you can wait a few weeks to make the count. A disadvantage of uneven germination is that thinning and harvesting is extra work when plants germinate and grow at different times, but a strength is that more of the seeds are likely to survive in the event of a drought or some interruption just after planting.

ECHO tries to test the germination of each active accession in our seedbank at least annually. The procedure we currently use measures emergence from the soil, in addition to seed viability as described above. (A seed may be alive, and it may even germinate, but emergence is the true test if it is to take root and grow.) It is a simpler test and allows us to transplant the plants after the test, as well. Count out, label, and plant a sample of seeds. Record the tally every week to obtain your germination rate.

**GERMINATING SEEDS CONTAINING CHEMICAL INHIBITORS.** Seeds of some wild species contain chemicals that inhibit germination. "For such species, continuous leaching in running water for up to two weeks is needed--washing or soaking is not enough." A recently published book, *Germination of Local Native Plant Seed for Revegetation, Tree Planting and Direct Seeding Projects* (Murray Ralph, A\$13.45 from Granny Smith), gives a novel solution. "The seed is placed in a permeable bag, such as a nylon stocking, and hung in your toilet cistern. The cycles of soaking and flushing produced in the cistern are ideal for easy breaking of the chemical-based dormancy." (Adapted from *Quandong*, Vol 21 #2, 1995; Nut and Tree Crops Centre, P.O. Box 27, Subiaco, WA 6008, AUSTRALIA.)



**TROPICAL ONION SEED GERMINATION** was poor, according to the seed trial reports many of you returned to us. Onion seeds are short-lived, so we were not surprised to see some reports of low germination in the field. However, the onion seeds in our seedbank were continuously tested for acceptable germination, and at ECHO we successfully grew many of the onion varieties for evaluation. Based on your results, we asked the researchers who supplied ECHO with the onion trials to send us fresh seed. This comment from their letter may explain why some people enjoyed great onion harvests while others had no germination:

"Please note that the onion seed sent to you is packaged very dry, so the packets should be opened and the seed allowed to take in moisture from the atmosphere overnight before the seed is sown. You risk damaging the seed by imbibition [water uptake] injury if it is sown straight from the packet into damp ground.

Another approach is to sow the seed into dry ground, then water it the following day. This also allows it to equilibrate naturally before it gets wet. Seed not wanted for use at once should be resealed in the foil packet immediately after removal of the amount you need, not allowed to remain open to the air for long."

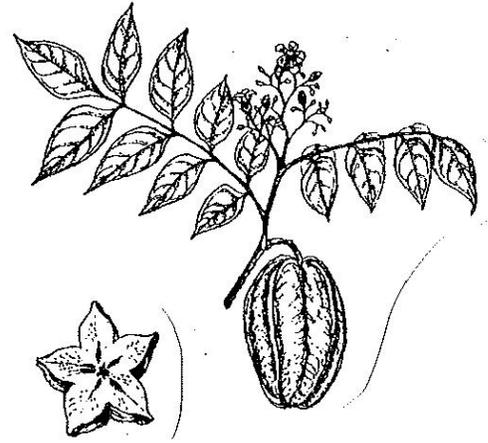
It is generally good to let well-dried seeds sealed in airtight packets absorb some moisture from the air before planting them directly in wet soil. Other seeds harvested at ECHO for our seedbank are dried thoroughly, but not so much that such imbibition injury is likely.

If you had poor results with the onion trials, write ECHO for more seed and let us know your results using this method. Your seed trial reports are very important to us in identifying problems such as this, as well as learning of successful introductions of the crops in our seedbank. Harvest report forms which accompany the seeds should be returned to ECHO. People interested in conducting an extensive onion study should contact Dr. Lesley Currah, Horticulture Research International, Wellesbourne, Warwick CV35 9EF, UK.

**CHART ON PROCEDURES FOR GROWING TROPICAL FRUIT FROM SEED.** The California Rare Fruit Growers publish the excellent magazine *Fruit Gardener*, which would be extremely interesting to folks working with fruits in the tropics. We copied a table from one issue that lists storage life of seeds, type of storage that is needed, dormancy breaking requirements, days to germination and cold hardiness. It covers 92 genera. We will send a photocopy to you upon request. Subscriptions (6/year) are US\$16 in US, \$25 Canada/Mexico, \$30 foreign surface, \$40 airmail from California Rare Fruit Growers, The Fullerton Arboretum, CA State University, Fullerton, CA 92634; 714/638-1796. This is among the favorite magazines in ECHO's library.



**WILL CARAMBOLA TREES COME TRUE FROM SEED?** Carambola fruit, *Averrhoa carambola*, also known as "star fruit" has gone from an obscure, inexpensive fruit in the U.S. to an exceptionally expensive "yuppie" fruit. When sliced, the star shape makes it popular on top of fruit salads, added to stir-fried vegetables, dried, or as a decorative addition to desserts. Most people in southern Florida who have tasted the old dooryard seedling trees find the fruit too sour to be of interest. They are usually amazed to taste the new, sweet grafted varieties. Since carambola bears at a young age and produces one of the heaviest crops of any small tree over a long season, the good varieties are great dooryard trees.



We wondered what would happen if ECHO sent out seed taken from fruit of one of the superior trees. Would it give fruit just like the parent, or would the fruit be sour and unappealing? To find out, we planted seven seeds taken from the commercial yellow Florida variety 'Arkin.' The great variation in shape and flavor is such a good demonstration of why people prefer grafted fruit trees (where every tree is like its parent) that we have left the entire planting to use in our educational program.

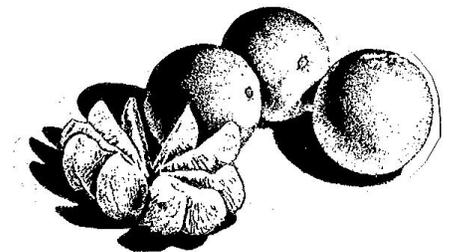
Trees began to produce fruit in 2-3 years. Four give orange fruit, but on three the fruit turns from green to nearly white, to pale orange as it ripens. Two of the orange-fruited trees are very sour, one is moderately sour, and the other is sweet. Two of the light-colored fruits are slightly sour with fair flavor, but we think that one tastes as good as or better than commercial varieties. (It will not become a commercial variety because the ideal commercial shape here is long with short "wings," which are less likely to be damaged in shipping. All these seedlings were shorter and had longer wings than the commercial varieties.) Several are good enough to leave for fruit production.

If you do not have sweet carambola in your country, you may request a packet of seed and we will send seed when available. Seeds reportedly cannot be stored, so we will probably send them in moist peat moss. They may be germinating by the time they arrive, so plant at once. You will probably find that you like fruit from some trees very much and some not at all. You may even find one that will be so good it will become a new variety for your country. (At ECHO we graft our best varieties to limbs of trees with sour fruit.)

ECHO's interns tell us carambola is one of their favorite juices. They remove any green tips on the "wings" (which can have an off-flavor) and mix with some kind of citrus juice and sugar. Dr. Julia Morton warns that the content of oxalates is so high that the fruit should not be consumed in large quantity. The less sour varieties have less oxalic acid. (An ECHO intern once read a research report which stated that most of the oxalates are found in the "wing tips" of the fruit, so presumably cutting off the tips could reduce the oxalate content. We have not been able to locate the report to confirm this, however.)

#### **WHAT VARIETIES OF CITRUS WILL GROW TRUE FROM SEED?**

Jerry Larson with Double Harvest in Haiti asked us what varieties of citrus might come true from seed. I checked with Dr. Carl Campbell at the University of Florida Extension research center, who gives us many in-depth, insightful answers to tropical fruit questions from our readers. He said that a great number of citrus trees will come true from seed. You can tell by examining a few seeds from the tree. Peel off the outer and inner seed coat; if the seed is polyembryonic (i.e. has many embryos) it will come true. (In some of the polyembryonic citrus, some of the embryos are of gametic origin and therefore do not come true. The percentage varies by species and variety.) I asked what it would look like if it were polyembryonic. Carl said that the various embryos would be convoluted upon each other. If it is mono-embryonic there will be one embryo with two distinct cotyledons. Almost any sweet orange will come true from seed, as well as key limes, grapefruit, tangerine and tangelo. Two varieties that will not come true from seed are temple and pomelo.



What are the advantages and disadvantages of growing citrus from seed when that is possible? One obvious advantage is that it is much less labor intensive to simply sow citrus seeds and eliminate the grafting step. Another advantage is

that the seedling will most likely be free from viruses that sometimes get into the budwood that is used for grafting large numbers of trees. I asked Carl about reports that non-grafted citrus trees live longer, up to twice as long, as grafted trees. He said that this can be true, depending on the number and kinds of disease organisms that may be present in the budwood. If one uses certified disease-free budwood, and if there are no microorganisms present that we do not even know to look for yet, then there should be no difference in the longevity of the trees.

One advantage to grafting is that one can combine the best traits of the above ground part of the tree with the best adapted rootstock for the particular soils and conditions of the area. A seedling will tend to grow upright, tending toward a single trunk, and becoming quite thorny. A grafted tree will be more highly branched. The seedling tree will not fruit for 6-7 years, contrasted to 3-4 years for a grafted tree. The earlier fruiting of the grafted tree is partly responsible for the more highly branched form of growth. Apparently the weight of the fruit after about 3 years bends the branches and causes new buds to begin growing, resulting in a more highly branched tree. But not all of the reasons for the differences between seedling and grafted trees are known.

If you live in an area where citrus is not a major crop but would like to introduce it, you might consider trying some of the polyembryonic seeds. If you are more adventuresome, in a few years also plant some accepted rootstock varieties for grafting using budwood from the new trees you have introduced. If you prefer to start with a Florida variety rather than a good local variety, and want only a few seeds, we can at times provide them. If you want larger amounts, request a price list from Chuck Reed at Reed Brothers Citrus (see below), who routinely ship overseas; he can provide phytosanitary certificates if you so request and include your full address and phone number. I asked about the danger of introducing a new disease. This does not appear to be a problem with citrus seed. A citrus disease has never been proven to have been introduced by seed.

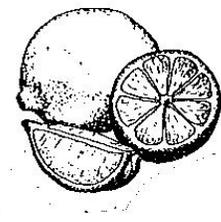
**PURCHASE OF CITRUS SEEDS AND BUDWOOD.** Carl Berg, a Peace Corps volunteer in Ecuador, inquired about citrus rootstock and how best to introduce assorted varieties of citrus into his part of the country. I phoned Reed Brothers Citrus for help.

Some rootstocks that they recommend for almost anyone, anywhere (though they sell many more) are: sour orange (no longer a commercial variety in Florida, as it is susceptible to the tristeza virus), 'Carrizo' citrange, 'Swingle' citrumelo, 'Cleopatra' mandarin and *Poncirus trifoliata* (trifoliolate orange). If there is no danger of freeze or frost, he would add to the list 'Volkameriana' for lemons and limes. Order sour orange and *Poncirus* before September of the year before so they can specially acquire seeds for you.

The prices per quart range from \$40 to \$70, so most of ECHO's collaborators would be unable to try more than perhaps one variety. I asked if he would be willing to prepare an assortment in smaller packets. He agreed to the following. You can send him \$50 for an assortment of some or all of those mentioned above, ask for an assortment of citrus that will come true from seed, or a combination of these options. He will arrange packet size to make the bill come out to \$50. We agreed to allow him some flexibility, as he would not have time for precise measurements, etc. You will receive approximately 1.5 pounds of seed. I would recommend that you add about \$20 for airmail postage, as citrus seeds begin to lose viability within a few weeks after removal from refrigerated storage. Alternatively, if someone in the States is about to visit you, the seeds could be sent to them via UPS. Mr. Reed is doing this as a favor to help your work and does not assume responsibility for delivery by international mail systems. Send your order, mentioning the ECHO package arrangement, to Mr. Reed at Reed Brothers Citrus, P.O. Box 1863, Dundee, FL 33838, USA; phone 941/439-1916; fax 941/439-4268.

The citrus canker scare in Florida has been cleared up, so Reed Brothers Citrus can ship budwood again; write them for a price list. You should be aware that many countries have strict budwood regulations, so check on your regulations before purchasing.

**ANSWERS TO SOME QUESTIONS ON CITRUS.** Two of our readers asked some interesting



questions about citrus. We called Reed Brothers Citrus (see above) for some help.

Q. (From William Boykin in Zambia.) "The navels, valencias and hamlins do not have the sweet flavors we had hoped. Is there anything we can do, or might it be the rootstock? We budded onto cape lemon."

A. The cape lemon rootstock is your major problem. Lemon rootstocks produce big quantities of fruit, but the quality is always poor. Lemon rootstock is for commercial juice production where they want to emphasize quantity. They then mix with smaller amounts of other juices to get the right taste. An advantage of the lemon stock is rapid growth, it being more vigorous than other stock. However, this also results in poor taste. Climate can also cause inferior taste. It would help if the climate were cooler. I would suggest budding onto either Carizzo or sour orange. They may not allow sour orange into the country because it is so susceptible to tristeza. For example, Brazil's citrus industry was wiped out some years ago by tristeza. But it depends a lot on how virulent is the strain in your country. It is so good that I would take the risk and not worry too much about tristeza. My third choice would be Cleopatra mandarin. The disadvantage with it is foot rot. This world-wide problem is caused when workers injure the root while cultivating. It is most susceptible during the first 5 years. The safest thing would be to use a combination of rootstocks. Then it will be unlikely that you will be wiped out.

If you wish to plant some true-to-type seeds I would recommend two varieties: ridge pineapple or what is called "old sweet seedling." By the way, any true-to-type seedling [plant grown from seed that will give fruit like the parent tree] is susceptible to foot rot.

Q. (From Peter van Lonkhuyzen in Haiti.) I have used budwood from some three year old trees that are not bearing fruit yet. Someone told me that by using such young trees my grafted trees will start bearing late and never will give good yields. Is this true?

A. A grafted tree will normally start bearing some fruit within a year. The fact that the parent trees you used were not bearing at three years suggests that they were seedlings. If so, you will have to wait about as long as if you had planted the seed.

There is one way you can get some quick budwood. Take budwood from a mature bearing tree and graft onto a rootstock in your area. As soon as this has grown to produce some branches, you can use this to bud other trees. They call this "first generation budwood." However, the second generation of trees should not be used for budding until they have started bearing.

Q. What rootstock should I use that is resistant to both drought and tristeza?

A. Sour orange is drought resistant, but if you want tristeza resistance also I would recommend Carizzo. Of course, even that is only drought resistant to a point. True-to-type seedlings will never tolerate drought as well as the normal rootstocks. I might also mention that a rooted cutting from any variety of citrus will have about half the normal life expectancy of a grafted citrus, due to susceptibility to a range of root diseases.

Q. How is it possible that in some places they have Washington naval trees without thorns while somewhere else the same variety has thorns?

A. There can be some differences in thorniness within a variety. In the one location they must have budded from trees that did not have thorns. You will still have some thorns of course. Alternatively, the thorny ones could be seedlings, as they tend to have more thorns.

I also asked about susceptibility to *Phytophthora* root rot. He said that rough lemon is one of the worst root stocks in regions where *Phytophthora* is a problem. It once was the primary root stock in Florida, but has been totally replaced. All citrus trees are susceptible to *Phytophthora* root rot to some degree. If a workman injures a root and the organism is in the soil, it can enter and damage the tree. It can then kill after a few months or just reduce production. Some trees in a row may become infected and others not. Budwood is not infected.

**ARE THERE DWARF CITRUS TREES?** Robert Weaver in Thailand asked us. From Dr. Carl Campbell: Yes, there are dwarfing citrus rootstocks. The research station in Florida has a few. I asked why almost no one is planting them. Carl said it is not that there is a problem so much as that no one knows just what to expect. The risk that in 8 or 9 years the tree might die is too great for large-scale movement to the untested rootstock.

### **GROWING YOUR OWN GRAFTED SUBTROPICAL VARIETIES OF DECIDUOUS FRUIT TREES.**

Dennis Desmond in Ecuador asked some interesting questions concerning a project to produce 5,000 fruit trees (subtropical varieties of temperate fruit) annually for local farmers. He already has a few apple, peach, pear, plum and apricot trees going that he can use for grafting material. Now he wants to begin growing rootstock [seedlings to which superior varieties will be grafted]. I know a lot of you have similar questions. For example, what kind of apple seed

should he buy, where would he get it, what pretreatment is needed, etc. This prompted a call to Dr. Wayne Sherman in the Fruit Crops Department of the University of Florida. A summary of this most interesting conversation follows.

In the States nurseries buy rootstock (very young trees) from specialized companies, usually in Washington and Oregon. Unless a particular name is specified, they most likely were grown from seed collected at cider mills. Dr. Sherman said that the easiest solution in the tropics also gives the best results--simply save seed from the subtropical fruits that are already bearing on your present trees. For example, Anna and Dorsett Golden apples will give better rootstock for a mountainous site in the tropics than would purchased seed taken from a cider mill in the States.

How can one get dwarf trees? He said that this is going to be expensive and hard to get. There is no good history of how they will do in the tropics, although the seedling stock is well adapted.

What about "clonal" propagation where trees are grown from root cuttings? The problem is that every tree will be genetically identical, in contrast to seedling trees which have a lot of genetic variability. If a particular pest comes along that is able to attack one of the trees, it will also successfully attack all the other clonally propagated trees! If trees came from seedlings there would be a much better chance that some would be resistant. For example, woolly aphids could wipe out an entire orchard if it were clonally propagated, but not if the rootstock came from seeds.

What kind of pretreatment is needed? After removing seeds from the apple, wash them. Put 100-500 moist seeds in a brown paper towel, roll the towel up, and place it in a refrigerator at normal refrigerator temperatures (40-50°F) for a month. Keep the towel moist. After a month start checking to see if seeds are germinating. They will probably start to germinate after about six weeks (longer if you were not starting with seed from the subtropical apples). At that point plant the entire bunch of seeds.

You should likewise save your own seeds from subtropical peaches. Crack the shell and put only the kernel in the moist paper towel. They should be ready to plant in about eight weeks. In three months they will be over two feet tall and are ready to T-bud. Five months later they can be set into the field. (In contrast apple trees must grow a year before grafting and another year before being set into the field.)

At higher elevations you may find a "Spanish" type of cling peach growing. If root knot nematodes are a problem in your area, however, you will have big trouble because peaches are susceptible to this pest. There is a nematode-resistant variety called nemaguard that is used for peach rootstock, but this would have to be purchased from a temperate country (importing a large package of peach seeds will not be easy or cheap). I asked if you could plant a nemaguard seed then in a few years have your own nematode resistant seeds. He doubts that it would ever produce because it requires such a long period of chilling. Clonal propagation of peach trees from the roots is very difficult.

Pears are treated the same as apples, again using any locally available pear seed. Plums are treated the same as peach. However, many prefer to graft plums onto the peach rootstock. Dr. Sherman said that plum seedlings vary so tremendously in vigor that three-fourths of them may not be usable. Apricots can likewise be grafted onto peach rootstock. (Do not graft peaches onto plum or apricot, nor plum to apricot, nor apricot to plum.)

**DIFFICULTY GERMINATING PAULOWNIA TREES?** We received many reports that our seed for *Paulownia* trees (no longer in ECHO's seedbank) is not germinating. Recently, "Tree Project News" reported that paulownia is extremely sensitive to shade and requires intensive light for germination and seedling growth. To determine whether light and surface planting were necessary, we undertook a simple trial in our greenhouse to ascertain the viability of our seed and the proper germinating conditions.

Nearly all seeds germinated in all of the experiments. What is different when the seeds are planted at ECHO? We can only guess. One possibility is that people are expecting a much larger seedling. Paulownia seedlings are very small (approximately 2-5 mm across) and can easily be overlooked or mistaken for weeds. The seeds did not germinate for three weeks, a bit longer than most familiar garden seeds. People may be giving up too quickly. Seedlings are exceptionally subject to damping off (being killed by fungus disease). They can probably germinate and die before they are even noticed.

Here is what we did. First we used sterile potting soil, in 6-packs. In one trial the seeds were barely covered with soil, placed in regular lighting, and received watering once per day. The second trial was similar except that the seeds were placed directly on the soil surface and placed in a mist chamber (soil was kept moist by a mist every few minutes). In the third trial the seeds were placed directly on the soil surface, covered with clear plastic and placed out of direct

sunlight. They were watered once a day. In most cases, 5-6 out of 6 seeds germinated, even when in the shade. The shaded trial, however, evidenced distorted growth of the small seedlings.

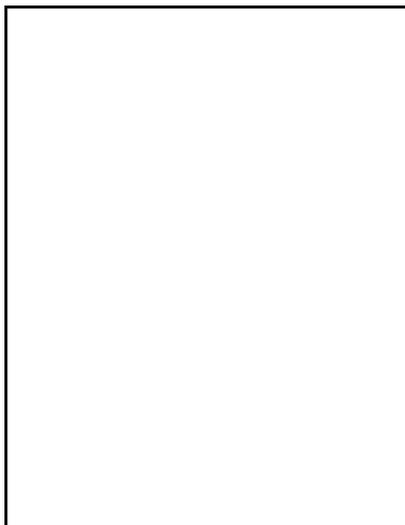
Here are our recommendations. You will need to give these seeds daily or twice daily care. Use sterile potting soil or treat with fungicide. Just barely cover the seeds (this will mean that they can dry out easily). Good intentions are not good enough--you must make sure that they never dry out whatever it takes to ensure that. If this will be too difficult, cover with a clear plastic, which must be removed as soon as they germinate to prevent fungal disease. Water very carefully so as not to wash seeds away or cover them too deeply by disturbing the soil. Place in bright light but not in direct sunlight. If sterile potting soil is not available you can sterilize your own by heating the soil over a fire or in an oven long enough to kill all microorganisms. If it is heated inside, the soil can give off a bad smell.

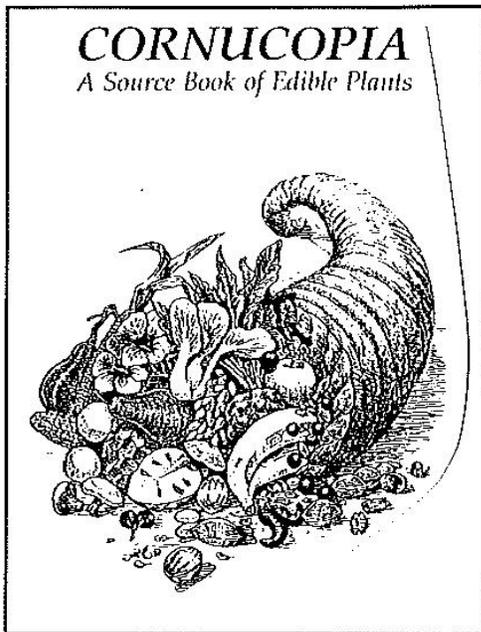
(By the way, ECHO no longer carries *Paulownia* seeds. The trees were discovered growing wild in West Virginia, USA in the late 1970s and since then they have received a lot of attention from researchers. A good source of information and seeds is Dr. Peter Beckjord at the National Paulownia Center, 10908 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. A source of *P. tomentosa* and *P. fortunei* is the Early Bird Nursery, c/o David Sutton, 2975 Salem Rd., Parrottsville, TN 37843, USA.)



## SEED PRODUCTION AND SOURCES

**AGRICULTURAL AND HORTICULTURAL SEEDS.** We turn to this useful 531-page book by the Food and Agriculture Organization to answer such questions as whether one of you can produce your own onion or cabbage or tomato seed in your region and, if so, how. The book is in two parts. Part I covers general principles, such as development, evaluation and choice of varieties, agronomy, drying, cleaning and storage, quality control and evaluation and seed distribution. Part II covers seed production of specific crops (11 cereal crops, 6 drug crops, 6 fiber crops, some florist crops, 13 grain legume and pulse crops, 8 forage crops, 10 oil crops, 9 tropical tree crops, and 22 common vegetables). For each crop, typical subjects include climate and soil, planting and cultivation, nutrition and irrigation, pollination and isolation, diseases and pests, and harvesting and threshing seed. Order for US\$26 (minus the 35% discount for developing countries) plus postage from Distribution & Sales Section, Food & Agriculture Organization, Via delle Terme di Caracalla, 00100 Rome, ITALY, or ask them if there is an FAO agent in your country. Price will not be the same in each country. In the USA, order from UNIPUB, 4611 F Assembly Drive, Lanham, MD 20706-4391.





**CORNUCOPIA: A SOURCE BOOK OF EDIBLE PLANTS** is one of those books I always wished someone would write. We are contacted weekly by folks looking for hard-to-find seeds. Our own seedbank contains many species, but as a service to our network we try to find a source if it is something we do not carry. Until *Cornucopia*, this was accomplished by looking one-at-a-time through the many catalogs we have accumulated over the years. If only someone would make a master index of all suppliers, world wide. Well, it's done.

In this 677-page paperback Steve Facciola has compiled descriptions and sources for 3,000 species of food plants (7,000 varieties). Names and addresses are supplied for more than 1,300 sources worldwide. Almost any edible plant you can imagine can be found, from vegetables and herbs to rare fruits and edible flowers. There are 226 pages of botanical listings by family (including fungi, algae, and bacteria) followed by 308 pages of cultivar listings, and 53 pages of sources. Then there's nearly 100 pages of useful information in the indices and appendices (vernacular names, uses of edible parts, families and genera, etc.).

Let's say we are looking for quinoa. The index of vernacular names tells us the Latin name is *Chenopodium quinoa*. The index of families and genera tells us that *Chenopodium* is found on page 66. On page 67 quinoa is listed as follows: "*Chenopodium quinoa*--Quinoa, Petty rice {S} The nutritious seeds are used in soups, stews, breads, biscuits, cakes, cereals, and pasta, or made into tempeh and

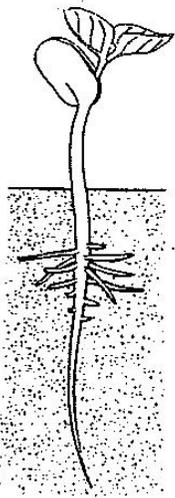
chicha. Young leaves can be used like spinach. Sprouted seeds are eaten in salads. An alkaline ash from the burned stems is chewed with coca leaf. Andean South America, cultivated." This entry is followed by 2 references and 13 different sources, both for seed (planting) and grain (eating). We are then referred to page 460 for information on cultivars (23 listed with descriptions and sources) and page 485 for specific information on methods of sprouting quinoa seeds.

The book is a wealth of information. Prices including postage are \$37.75 US; overseas \$40.25 surface and about \$56 airmail. Order from Kampong Publications, 1870 Sunrise Drive, Vista, CA 92084, USA. (See the chapter on Multipurpose Trees for details on a similar sourcebook for multipurpose trees and inoculants.)

**ARE FREE SEEDS A GOOD IDEA?** We frequently get letters lamenting that gardeners cannot obtain vegetable seed. Dr. Henry Munger at Cornell University told me that a seed company tried to get started in the Philippines some years ago. About the same time both a U.S. agency and Mrs. Marcos began a free seed distribution program. He believes this put the company out of business. The donors soon tired of giving away seeds, leaving the people with no place to buy them.

The owner of a small seed store in a tropical country told me there was an onion seed shortage in his region the year I visited him. He had used his hard-earned foreign exchange to import onion seed the previous year. Then one day a nearby mission began selling onion seed at much below wholesale price, as someone had given them the seed. The next year the seedsman was wise enough not to get caught with onion seed again, but the mission did not give away seed that year. Consequently there was a shortage of seed for one of the major crops of the region.

With very few exceptions, farmers can save their own seed from plants grown from the kind of seed that ECHO provides. In the long run, it is much more helpful to enable local people to take care of themselves than to bail them out sporadically with gifts. This is the ministry that ECHO is continuing and expanding. Development is more lasting than relief.



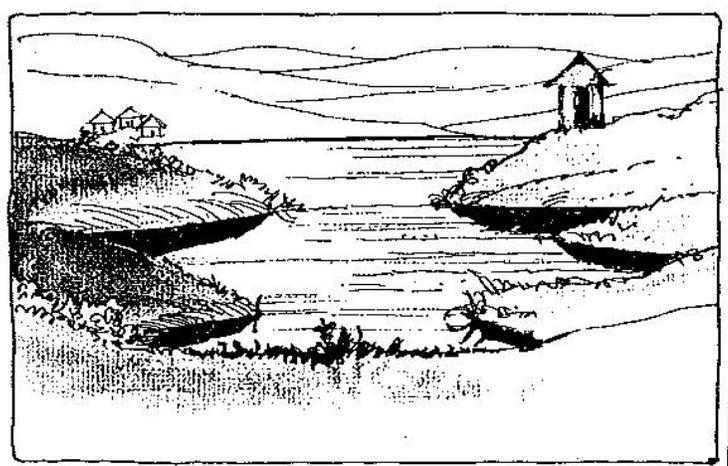
**SEEDS FOR THE AMERICAS** sends garden seeds to participating agencies throughout Latin America and the Caribbean (please only write if you are in these areas). End users might include needy individual families, orphanages, schools, churches, 4H clubs, community groups, prisons, etc. One unit of 1,400 packets of seeds normally include 12 kinds of vegetable and two kinds of flower seeds for each garden, packed 100 packets of each seed per bag. The quality of the seed is checked by Mississippi State University before packing. They charge 3¢ per package to help defray costs.

I asked whether seeds were selected for various micro-climates. "The seed we distribute is very well received, but has not been tested in all the microclimates in which they may be used. In many cases the varieties/hybrids are superior to what is available locally. Seeds distributed in the program are for vegetables that are normally grown and have proven successful in many places in Latin America and the Caribbean." If your organization is interested, contact John Batcha for further details: 4947 Foxbriar Trail, Charlotte, NC 28269, USA; phone/fax 704/597-7789; e-mail GGFG89A@prodigy.com. This is one resource for those situations in which supplying free seeds to gardeners may be appropriate. But please also consider the following issues.

Some words of caution. Though such seeds can be a blessing, you need to be aware of certain pitfalls. If your idea is to just request seeds and then give them out, please don't.

1. This is old seed, and it might not germinate. ECHO has planted seeds that were donated to us. Most of the time, the results are excellent. But every so often we have done the work of preparing the soil, planting and watering only to find that the seed was dead. That is frustrating to anyone--and can quickly ruin your credibility. Damage can be even worse. If there is a short period during which gardens must be planted, there might be no time left for replanting. Your effort to save them the cost of seed may have lost them their entire harvest.

I would absolutely never distribute free seed to farmers unless I had tested its viability first. Just plant a few seeds from a packet or two of each variety near your home and see what percent comes up. There is no need to use normal spacing, as this is just a test. Perhaps 50 seeds half an inch apart would suffice. Not all packets of a particular vegetable may be good; some may have been in a store without air conditioning. One way to make sure that the occasional farmer does not get one of these bad packets is to open every packet of that species, mix thoroughly, and check viability in bulk. If it is acceptable, repackage in some manner.



2. The seed may be good, but the vegetable will not grow in your location. If farmers or gardeners in your area are used to and fond of the idea of experimenting, they may enjoy finding out. Others may lose interest very quickly. Except to such experimenters, I would never give out seed for a vegetable I had not grown myself or seen grown in the community. (If your climate is mild due to high elevation and rainfall is uniform, there is a good chance that most temperate vegetables will grow. If you are in the hot lowlands, many will not.)

3. Only some varieties of a vegetable may be adapted to your area. For example, varieties may differ in susceptibility to disease. Most varieties of cucumber will not produce here in our hot, humid summers, but the 'Poinsette' variety does give some fruit. Be especially wary of onion seeds. Only seeds marked "short day onions" have any chance of forming bulbs in the short days found in the tropics and subtropics. Others will produce leaves and stems for green onions.

4. You can disrupt local businesses, as in the article above. Any retailers who may be selling seeds in your community provide an essential service. If you distribute free seeds on any substantial scale to people who normally buy from a local business, they may stop carrying seed or reduce inventory. What will farmers do in a year or two when you are on furlough for a year or distributing seeds is no longer a priority for you?

5. The seed may be a hybrid. For many vegetables, seed saved from hybrid plants gives unpredictable results and often inferior plants. If farmers do not save their own seed, hybrid seed might be preferred. But if some farmers save their own seed for the next season, they may be hurt next year and you may not even know you caused it.

**SAVING SEEDS FROM HYBRIDS?** [The following is based on an article in *International Agricultural Development* July/August 1994.] Research aimed at transferring the "apomixis" gene from a wild grass into rice could result in farmers being able to save seed year after year from hybrid plants. Normally the special traits that cause farmers to purchase hybrid seeds are lost if seed from that crop are saved and planted and yields may be low and unreliable. "Plants with the apomixis gene are able to reproduce *asexually* through their own seeds" (i.e. without cross-pollination). So these seeds would be identical to the original hybrid seed. "Although the apomixis gene occurs in around 300 wild plants, it is rare in crops of economic importance. Wild plants are so different that scientists have had little success in transferring their genes into domesticated crops."

Scientists at CIAT in Colombia have identified "markers" for apomixis in a grass called brachiaria and confirmed that in this grass a single dominant gene controls apomixis ("This is a little like finding the road signs"). When the gene is found, the next step is to clone it into unrelated crops. "Cloning may take 3-5 years."

**BAMBOO BREEDING.** Have you ever thought how frustrating it would be to be a graduate student in plant breeding studying bamboo? You could only make the crosses between varieties when they flowered. In bamboo, flowering occurs most commonly after 30 years, but can be on other multiples of 15, even 120 years for different species. Then there is the problem that the two varieties you wanted to cross might not flower at the same time. That is why this terribly important plant has never been improved by plant breeding.

Dr. Larry Butler at Purdue University alerted us to a breakthrough (*Nature*, vol. 344, p 291, 1990). Researchers have found that "tissue cultured shoots from bamboo seedlings on medium supplemented with cytokinin [a plant hormone] and coconut milk flowered ... after only three subcultures." The varieties they work with would normally flower after 30 years. Similar advances have been found with other species. For example, date palm shoots can be made to flower in five months after tissue culture rather than the usual 9 years.

There should now be "an explosion of new types [of bamboo]...". There is plenty of variation to choose from in making crosses. "Leaves, for example, vary between species from great sheets 4.15 meters long and 30 centimeters wide (on a plant only 3 meters high) to hair-like threads." "Bamboo hay has four times the protein content of hay from grasses and paper from bamboo is much better than newsprint."

**WHERE CAN I FIND SEED FOR BREADFRUIT?** We were recently asked that question. Actually breadfruit does not produce seed. It must be propagated asexually. On a recent trip to Malaysia, however, I learned from Dr. Lee Ming Yong at the Tenom Agricultural Experiment Station that they are able to V-graft breadfruit onto breadnut trees. The breadnut has a lot of seeds.

**HOW TO PRODUCE CARROT SEED WHERE WINTERS ARE NOT COLD.** We often hear from people in our network who want to do gardening projects, but who are frustrated because seeds are not available in local stores or people cannot afford the seeds.

We have become so dependent on seed companies that we forget they have only been around a century or so. Except for situations where weather interferes with the harvest, there should be no need to purchase seed for any non-hybrid vegetable that produces seed in your garden. Just save your own seed. (Seeds saved from hybrid plants usually give unsatisfactory results, which is why we do not recommend hybrid plants for most situations. Because it is difficult to tell if a seed-containing vegetable in the local market has been grown from hybrid seed, it is safer to start with known non-hybrid seed. On the other hand, local produce may have been grown from especially well adapted varieties passed on from generation to generation, so it may be worth a try.)

There is a tendency for people who grew up in temperate climates to think only of vegetables that were popular there. Do not forget that the bulk of vegetables in a tropical garden should probably be what I refer to as "plants that God created for that climate." However, the temperate vegetables are good and often bring premium prices if a way can be found to obtain seed and to grow them.



Not every temperate vegetable will produce seeds in the tropics. If the following grow in your community, you should have no problem saving your own seed: pumpkins, squash, eggplant, cucumber, lettuce, peppers, corn, radish, or tomato. You will probably need to purchase onion, leek, carrot, kale, beet, and cabbage seed. However, if you are willing to do some extra work, there is a way to produce carrot seed in most climates where carrots will grow. [ECHO has seed of the Uberlandia carrot which produces seed in one season in the tropics. However, this carrot is presently not selected enough to be of immediate commercial value: there is much variation in the carrots and the quality is generally lower than commercial carrot varieties.] The Beta III carrot from ECHO is not a hybrid, so you can use it to produce your own seed. The following is abstracted from a bulletin provided by Dr. Simon, who works extensively with carrots.

Carrots do not produce seed in the tropics because they are biennials. Carrots need two growing seasons with a period of cold (vernalization) in between. To produce seed, first grow plants and harvest roots as you normally would. Discard or eat any that are not "ideal" carrots. Pencil-sized roots will do, but larger roots are preferable.

Trim the tops back to 2-4 cm, trim off lateral and fibrous roots, gently wash off the soil, and remove any yellowing leaves. Let the carrots dry on a shelf out of the sun until no surface moisture remains, pack in paper bags with an equal volume of wood shavings, and place in closed polyethylene bags in the refrigerator (2-5°C). After several weeks when water droplets accumulate inside the plastic bags, puncture the bags.

Even with all these precautions, carrots are very susceptible to infection during storage. In commercial production the roots are dipped in fungicide before vernalization, but this is dangerous unless you are CERTAIN that no one will be tempted to eat the carrots.

The next season plant the vernalized roots, taking care to keep them well-watered but not in standing water. Seed stalk development will be evident in 4 to 6 weeks. It is very difficult to produce carrot seed where warm humid climates favor microbial growth. Control of fungal diseases and insect pests is essential. If the wild carrot, queen anne's lace, grows nearby, it will cross and yield white-rooted plants.

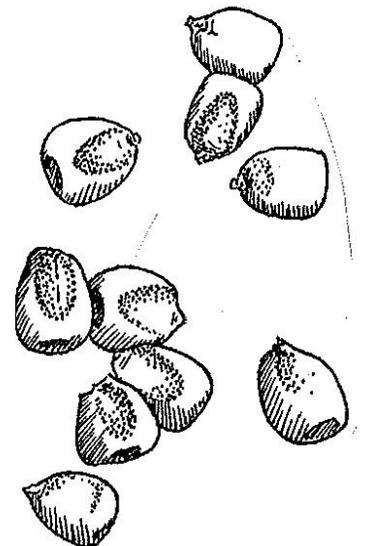
Pollination is by bees or flies. Alternatively, pollen movement is possible by hand or brush, but seed set will often be low. Within 4-6 weeks after pollination the developing seed turns brown. Before the seed shatters, harvest and place into paper bags to dry completely. If rains occur just before harvest, the yield of seed can be reduced drastically. Perhaps you can adjust planting time to increase the likelihood of dry weather while seeds are ripening. Remove spines from dry seed by rubbing. Because carrot seed requires no dormant period, the seed is now ready to plant. Store dry seed in a moisture-proof container in a refrigerator if possible.

#### **HOW FAR APART MUST CORN BE KEPT TO PREVENT CROSS-POLLINATION BY OTHER LOCAL VARIETIES?**

Ray Vander Zaag in Haiti asked this question because he wanted to increase seed for the high lysine corn. I referred to *Agricultural and Horticultural Seeds* for the following summary. Because corn is pollinated by the wind, a considerable distance is required to eliminate the possibility of cross-pollination. In U.S. seed production, different varieties are isolated at least 180 meters, though the distance depends on normal wind velocity in the area. In South Africa varieties are kept 360-740 meters apart.

Natural barriers such as tall trees are useful, and give extra safety in case of very strong winds. Often several rows of the same variety are planted around the field as "border rows." The seed from these border rows are used as food, but not saved for seed. A good general practice would be to harvest seed from the interior parts of the field if neighboring farmers are growing other varieties of corn.

If the ideal distance cannot be maintained, you can reduce the required distance by either (1) increasing the size of your field or (2) planting several border rows. For example, a 16 hectare field requires 165 meters separation from other varieties and a 4 hectare field 200 meters. The effect of having several border rows can be dramatic. The same 16 and 4 hectare fields with 13 border rows require only 15 and 50 meters separation, respectively.



**GROWING GARLIC.** Why is garlic grown using vegetative material rather than seeds? The Asian Vegetable Research and Development Center (AVRDC) publication *Centerpoint* says it is because of sterility in garlic. This limits scientists' ability to improve the plant as well. Recently AVRDC scientist Dr. C. S. Pathak found garlic clones that flower. So far, eight clones of this flowering type have been collected in Taiwan, but pollen fertility was noted in only one. Hand-pollination resulted in excellent fruit development with healthy embryos. "This points to the possibility of seed production in tropical garlic."

Laura Raab wrote from Kenya: "Some time ago I asked you how to get garlic to sprout and you referred me to Dr. Pathak with AVRDC in Taiwan. His answer is so simple that I thought it might benefit others. He said that the problem in sprouting garlic cloves may not be dependent only on temperature. The age of the bulb is equally important. If bulbs are freshly harvested, it is very difficult to get them sprouted. Bulbs which have been stored for 3-4 months will easily sprout once you put them in soil."

**SAVING YOUR OWN LETTUCE SEED.** Beth Adams and Mike Fennema in Haiti had decent production with three varieties of lettuce, but some started to go to seed. They asked whether they needed to be concerned about cross-pollination between varieties and for suggestions on harvesting. A frequent problem with lettuce in the tropics, or during hot weather anywhere, is that the plants quickly bolt (send up seed stalks). That is actually good news for seed production, as long as rainfall and humidity are not so high that the seeds are damaged. If the variety performed reasonably well for you, and was not a hybrid, it should not be difficult to save your own seed. The following is excerpted from *Agricultural and Horticultural Seeds*.

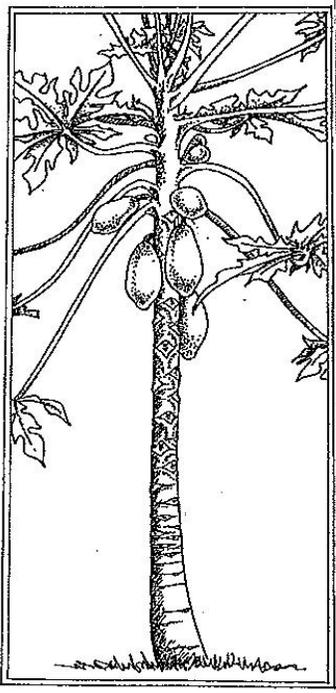
Lettuce is mainly self-pollinated, but there can be 1-6% cross-pollination by insects. For pure seed production different varieties should be isolated by at least 30-60 meters OR separated 2-4 meters by a thick fence or tall-growing crop. The seed stalk may not be able to emerge from varieties with compact heads. In such cases the heads can be removed or cut in quarters with a sharp knife when mature.

Seed ripens unevenly and fully mature seed shatters readily. For large scale seed production it is advisable to harvest when 30-50% of the seeds in heads show white fluff. Heads are left on the ground for a few days to dry. In the U.S.A. plants are cut and windrowed when most flower heads are still yellow, and left to dry. These are later harvested with a combine. For hand harvesting, people either pick individual flower heads as they ripen or bend plants into a large bag and shake gently to remove ripe seed.

ECHO intern Karen Ebey found an easy way to separate the tiny black seeds of lettuce from the fluffy material to which they are attached. She placed the freshly harvested material in a cup and stirred briskly with a fork. The seeds quickly settled to the bottom. Seeds can be stored up to six years in a cool, dry place. In the tropics it can be stored in airtight containers for six months if thoroughly dried first to a moisture content of 8-10%.

**ONION VARIETY TRIAL.** Dr. Lesley Currah has put together seed for a large onion variety trial that she sends to researchers around the world. Most members of ECHO's network would not have the resources to qualify to participate in such a large trial. However, she has sent one trial for ECHO to subdivide and make mini-trials available to you. We divided them into sets of six varieties each. We will send two sets at no charge to development workers assisting peasant farmers or to university researchers. When you report the results you can request another set. She asks that you be sure to include the best local varieties in your trial for comparison.

Dr. Currah is interested in learning how the onions grown from these seeds perform in many different environments. If you are willing to take some careful data, indicate this in your letter. We will then send some special report forms that she has provided, rather than ECHO's general forms. Formal researchers who need both more varieties and more seeds of each, write to Dr. Currah directly to inquire about joining her onion research network: Horticulture Research International, Wellesbourne, Warwick CV35 9EF, UK; fax 0789-470552.



**THE SOLO PAPAYAS ARE GREAT, BUT...** We received a request from Honduras wanting to know where they could purchase several pounds of solo papaya seeds. Solo papayas have two (at least) special characteristics: (1) Each tree produces fruit, so you do not have to worry about whether a tree is a male or female and (2) the fruit are grapefruit-sized, about the right size for one meal and by far the most popular size in the U.S. market.

I understand the urgency to grow something on a large scale and take advantage of an export market. However, as a scientist I am always cautious about doing anything on a large scale until the new species or variety has been tried under local conditions. The solo papaya is at special risk, including the definite possibility of a serious crop failure. Though a failure might not occur right away, it would always be a threat. I called Dr. Carl Campbell at the University of Florida experiment station for more details.

Dr. Campbell said that papaya ring spot disease is a serious problem here in Florida and is definitely present in Honduras. Because the solo types are so popular on the export market, people are planting them in the Caribbean in spite of the threat of disease, but may have to cut them down and replant every year or two. They apparently think the superior market price is worth it.

There is a resistant variety, however, called the Cariflora. It was developed at the experiment station in Florida. Dr. List, the man in charge of this research, said there is heavy disease pressure in Central America, both with the ring spot and a couple other viruses. Solo papayas do not do well there at all. He has only seen virus-free solo papayas in one

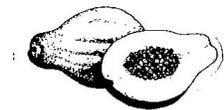
location in Central America (in Costa Rica). He felt our friend would probably not even get a crop. One man in Costa Rica who tried many varieties had to cut down the solo varieties without a harvest.

Because these virus diseases seem to attack cucurbits (e.g. cucumber), it may be difficult to grow solo papayas if there are serious cucurbit virus diseases in the area. Ordinary solo papayas have been taken out of production now in Taiwan. They currently grow only the Cariflora. It is about grapefruit size, neither as small nor as sweet as the solo. However, it is close to the general size demanded in U.S. markets. ECHO has a small quantity of seed in our seedbank to share with people overseas. By the way, the regular solo papayas do great for us here in southwest Florida and just might for you as well. You can order seed inexpensively from the Seed Program, Dept. of Horticulture, University of Hawaii, 3190 Maile Way, Room 112, Honolulu, Hawaii, 96822, USA.

**MALAYSIA EXOTICA PAPAYA** (Overseas network only). I toured agricultural research stations in Malaysia with a group. I especially enjoyed the papaya we were served by Dr. Tony Lamb at the Tenom Agriculture Experiment Station.

The "solo" sunrise papaya from Hawaii that is so successful commercially does not do exceptionally well in Malaysia. (It also does not do well in many parts of Central America and the Caribbean, where it is badly affected by virus diseases.) However, the solo has many positive characteristics. Every tree will bear fruit, in contrast with most papayas for which half of the trees are males which bear nothing. The fruit is small enough (grapefruit size) that the entire fruit can be used without the need to store leftovers. The flavor is good and there is no objectionable smell.

So the sunrise solo was crossed with suban, a local Malaysian papaya, then backcrossed again to solo. The resulting fruits have a deep orange color and great taste and smell. The trees are better adapted to the heat and other conditions in Malaysia.



We can share some small packets with our network. If they do well for you, you can keep the line pure by harvesting seed only from the hermaphroditic fruit (same flower has both male and female parts). Dr. Lamb said that if you plant seed from a hermaphroditic papaya, 1/3 of the trees will be female (F) and 2/3 will be hermaphroditic (H). (Half of the trees grown from seeds of female solo trees pollinated by solo trees will be 1/2 F and 1/2 H. Trees grown from seeds of a female solo pollinated by a male tree will be 1/3 each H, F, and M.) At the research station trees are marked either F or H, then seed is saved only from the H trees. Hermaphroditic fruits bring a better price too. They are oblong with a small seed cavity compared to fruits of female trees which are round with a large seed cavity.

**WHY IS THERE SUCH HIGH TURNOVER IN THE TREE SEED BUSINESS?** Starting a tree seed company

would be one of my last choices if my goal were to make money. The reasons for my opinion may also explain why there are so few companies that specialize in this for a long period of time.

The market for seed of a particular tree is impossible to predict. Much depends on what publicity that tree has recently received or what the latest research results have been. In a given year, one group may receive a grant to do a large project and decide to order a large quantity of seed for a particular tree--but perhaps no other group in the world is making a large planting of that tree that year. The storage life of tree seeds ranges from a few weeks to years, and in some cases no one even knows.

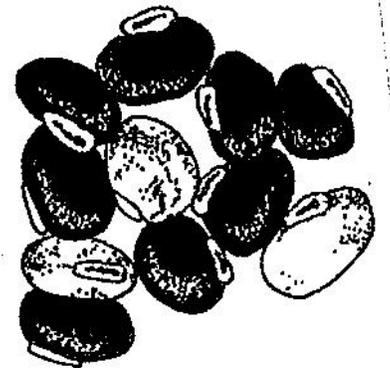
About the only way to keep the company's inventory under control and still assure the customer of quality seed is to collect seed after receiving the order. This is the policy of many companies, so do not be surprised if you cannot just mail off a check and receive seed in a few weeks. Especially if you have a large project, be prepared to make your order months ahead of the time you will need the seed. If seed comes from stock on hand, be sure to ask when it was harvested, how it was stored, and the life expectancy of the seed.

**ROY DANFORTH AND PAUL NOREN'S TROPICAL FRUIT TREE PROJECT IN ZAIRE.** [Excerpted from their December 1990 "Zaire Rare Fruit Newsletter."] The agroforestry project has suddenly captured the interest of the Zairians like never before! Nurseries have been established in selected villages for a faster method of fruit tree distribution. This has proven very successful as many of these villages have trees planted everywhere: people's yards, school or church yards, etc. They cannot keep up with the demand. The interest in fruit trees is on the rise because food is more scarce, because some of the trees are starting to fruit, and the growers really enjoy the new tastes! Rollinias, jackfruits, star apples and canistels are coming into production and are immediately becoming favorites with the Zairian people.

Seed is available on an exchange basis [though it is hard to imagine that anyone would have something that Roy and Paul still need!] or payment of one U.S. dollar per small packet. [Ed: I'm sure they will lose money at \$1 per packet, so be generous if you can. ECHO seeks special funding to give things to our network, but Roy is one of you, which means that his funding is for work in his community.]

I am taking the liberty of listing just a few of the trees for which he is offering seed. The number(s) in parenthesis show the month(s) during which seed can typically be collected; e.g. (12-3) means December through March. Get orders in early so they can plan to collect what you need. His list contains many, many more trees that are not yet fruiting, that are lesser known or that are reforestation species. To get a copy of his list, write Roy Danforth, B.P. 1377, Bangui, CENTRAL AFRICAN REPUBLIC.

*Achras sapota*, Sapodilla (4); *Adansonia digitata*, Baobab (8); *Anacardium occidentale*, Cashew (12-3); *Artocarpus altilis*, Breadnut (most); *Artocarpus heterophyllus*, Jackfruit (most); *Averrhoa carambola*, Carambola (most); *Cinnamomum zeylandicum*, Cinnamon (rare); *Coffea* spp. (*liberica*), coffee (1-2); *Coffea robusta*, Coffee (10 & 1-2); *Coffea arabica*, *C. arabica* x *C. robusta*, Coffee (most); *Cola acuminata*, kola nut (most); *Elaeis guineensis*, Oil palm (most); *Eriobotrya japonica*, Loquat (8); *Garcinia livingstoneii*, Imbe (all); *Garcinia mangostana*, Mangosteen (7,8); *Macadamia tetraphylla*, Macadamia (1-2); *Morus indica*, Mulberry (most); *Muntingia calabura*, Strawberry tree (most); *Murraya koenigii*, Curryleaf tree (most); *Nephelium lappaceum*, Rambutan (8-9); *Passiflora* spp., passion fruit (most); *Pouteria caimito*, Abiu (6); *Psidium* spp., Guava spp. (8); *Theobroma cacao*, Cocoa (8-12); *Treculia africana*, African breadnut (8); *Zizyphus mauritiana*, Indian jujube (8).



**MORE SEED SOURCES.** It is very difficult to keep current information about seed companies. Unless they regularly send us new catalogs, we cannot be sure they are still in business or in the same location. We appreciate it when our network lets us know of their experiences with buying seed or plants: reasonable prices, helpful service, prompt delivery, quality of the plants, etc. If you try to contact a company listed here without success, please let us know that as well. The following list includes the most current information we have on seed or plant suppliers. If you cannot find sources of the seed you need through these groups, we can try to locate another source for you. Continue to let us know of more sources.



**Wide selection and vegetables.** The Inland & Foreign Trading Co. (Block 79A, Indus Road #04-418/420, Singapore 0316; phone 2722711; fax 2716118) is an excellent source of leguminous cover crop and pasture species (specialty), fruit trees, ornamental and flowering trees, and more. J.L. Hudson, Seedsman (Star Route 2, Box 337, La Honda, CA 94020, USA) offers a tremendous variety of seeds in the "Ethnobotanical Catalog of Seeds," including agroforestry species, unusual vegetables, flowers and ornamentals, and plants used medicinally, in small packets and at very reasonable prices. Seed Savers Exchange (3076 North Winn Rd., Decorah, IA 52101, USA) members maintain a tremendous variety of rare heirloom vegetable, herb, fruit, and other seeds. Native Seeds/SEARCH (2509 N. Campbell Ave. #325, Tucson, AZ 85719, USA; phone 520/327-9123; fax 520/327-5821) offers a 50% discount to native peoples on their tremendous selection of amaranth, beans, chili peppers, corn, cucurbits, okra, tomatoes, flowers, and more, suitable for very hot and dry conditions; some are adapted to higher altitudes as well. High Altitude Gardens (P.O. Box 1048, Hailey, ID 83333, USA; phone 208/788-4363; fax 208/788-3452; e-mail [higarden@micron.net](mailto:higarden@micron.net)) specializes in frost-tolerant, quick-maturing varieties for cold climates; their catalog lists over 300 varieties of vegetables, plus herbs, wildflowers, and grasses. 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) offers high-quality seed of select varieties of solo papaya, pole bean, lettuce, sweet corn, eggplant, tomato, and other vegetables. Shivalik Seeds Corporation (47, Panditwari, P.O. Premnagar, Dehra Dun-248 007 (U.P.), INDIA; phone 91-135-683 348; fax 91-135-29944) offers seeds of a wide range of (agro)forestry, medicinal, horticultural, ornamental plants. CIMMYT (Centro Internacional de Mejoramiento de Maíz y Trigo, Lisboa 27, Apartado Postal 6-641, 06600, MEXICO D.F.) has improved varieties of corn and wheat, including Quality Protein Maize. Plants of the Southwest (Agua Fria, Rt. 6 Box 11-A, Santa Fe, NM 87505, USA; phone 505/471-2212; fax 505/438-8800) has corn, cover crops and vegetables for arid gardens. Richters Herb Specialists (Goodwood, Ontario LOC 1AO, CANADA; phone 905/640-6677; fax -6641; e-mail [orderdesk@richters.com](mailto:orderdesk@richters.com)) has a very complete herb listing. Tomato Growers Supply Co. (P.O. Box 2237, Fort Myers, FL 33902, USA; phone 941/768-1119; fax -3476) has a huge selection of tomato and pepper varieties. Twilley Seed Co. (P.O. Box 65, Trevoise, PA 19053, USA) has common temperate vegetable and flower seeds. Pax World Service compiled a list of 36 non-profit international seed distributors in 1996; write them at 1111 16th St., NW, Suite 120, Washington, D.C. 20036, USA; phone 202/293-7290; fax 202/293-7023; e-mail [paxwldsvc@aol.com](mailto:paxwldsvc@aol.com); web site <http://members.aol.com/paxwldsvc>.

**Fruit trees.** ECHO has an Edible Landscape Nursery, which includes many varieties of tropical fruits. *ECHO does not ship plants at all*, but if you visit us en route overseas, you might be able to take a few plants or cuttings with you. The Pacific Tree Farms (4301 Lynwood Drive; Chula Vista, CA 91910, USA; phone 619/422-2400) has quite a listing of grafted or air-layered tropical fruit trees, NOT SEEDS, for sale. They are expensive (average US\$38). However, if you want one tree of a particular variety to provide you with budwood in a year or two, they may be the answer. They will ship overseas, but that will be expensive too. The Chestnut Hill Nursery (Rt. 1, Box 341, Alachua, FL 32615, USA; phone 800/669-2067 or 904/462-2820; fax 904/462-4330) specializes in chestnuts, persimmons, and temperate/subtropical fruits (apple, pear, peach, fig, grapes, blueberry, citrus, berries, etc.) and nuts at reasonable prices. Peter B. Dow & Co. (P.O. Box 696, Gisborne 3800, NEW ZEALAND) is listed in *Cornucopia* as a source of fruit tree seeds. Fruit Spirit Botanical Gardens (Dorroughby, N.S.W., AUSTRALIA 2480; phone 066 895 192) has a very extensive listing of tropical fruits and nuts, gingers, and other plants. Small packets are A\$5, and bulk seed is available. The Borneo Collection (Treefarm, El Arish, North Queensland 4855, AUSTRALIA) has South American, Southeast Asian, and Borneo species available seasonally. CATIE (Centro Agronómico Tropical de Investigación y Enseñanza, BLSF, Turrialba, COSTA RICA) supplies fruit and forest trees.



**Pasture and/or tree seeds.** Samuel Ratnam, the director of The Inland & Foreign Trading Co. (see above), sent us a 2-page listing (prices only upon specific inquiry) of pasture, cover crop and shrub/tree seeds, which they have marketed for 40 years, especially to plantations, ranches and reforestation programs. Many pasture grasses and legumes are available from Frank Sauer and Sons (P.O. Box 117, Rockhampton 4700, Queensland, AUSTRALIA). The Australian Revegetation Corporation (Kimseed; 42 Sarich Court, Osborn Park 6017, Western Australia; phone 09-446-4377; fax 09-446-3444) catalog lists over 200 different species of *Acacia*, 19 species of *Casuarina*, over 500 species of *Eucalyptus*, and much more. Tropical, subtropical and temperate grasses and legumes for pastures and ground covers are also listed; for example, they have 9 species (29 varieties) of *Trifolium* (clovers) and 9 varieties of *Medicago* (alfalfa). M.L. Farrar PTY. LTD. (P.O. Box 1046, Bomaderry NSW 2541, AUSTRALIA; phone 044-217966; fax 044-210051) has a huge selection of trees. Agroforester Tropical Seeds (P.O. Box 428, Holualoa, HI 96725, USA; fax 808/324-4129; e-mail [agroforester@igc.org](mailto:agroforester@igc.org)) sells seed and also produces *Rhizobium*

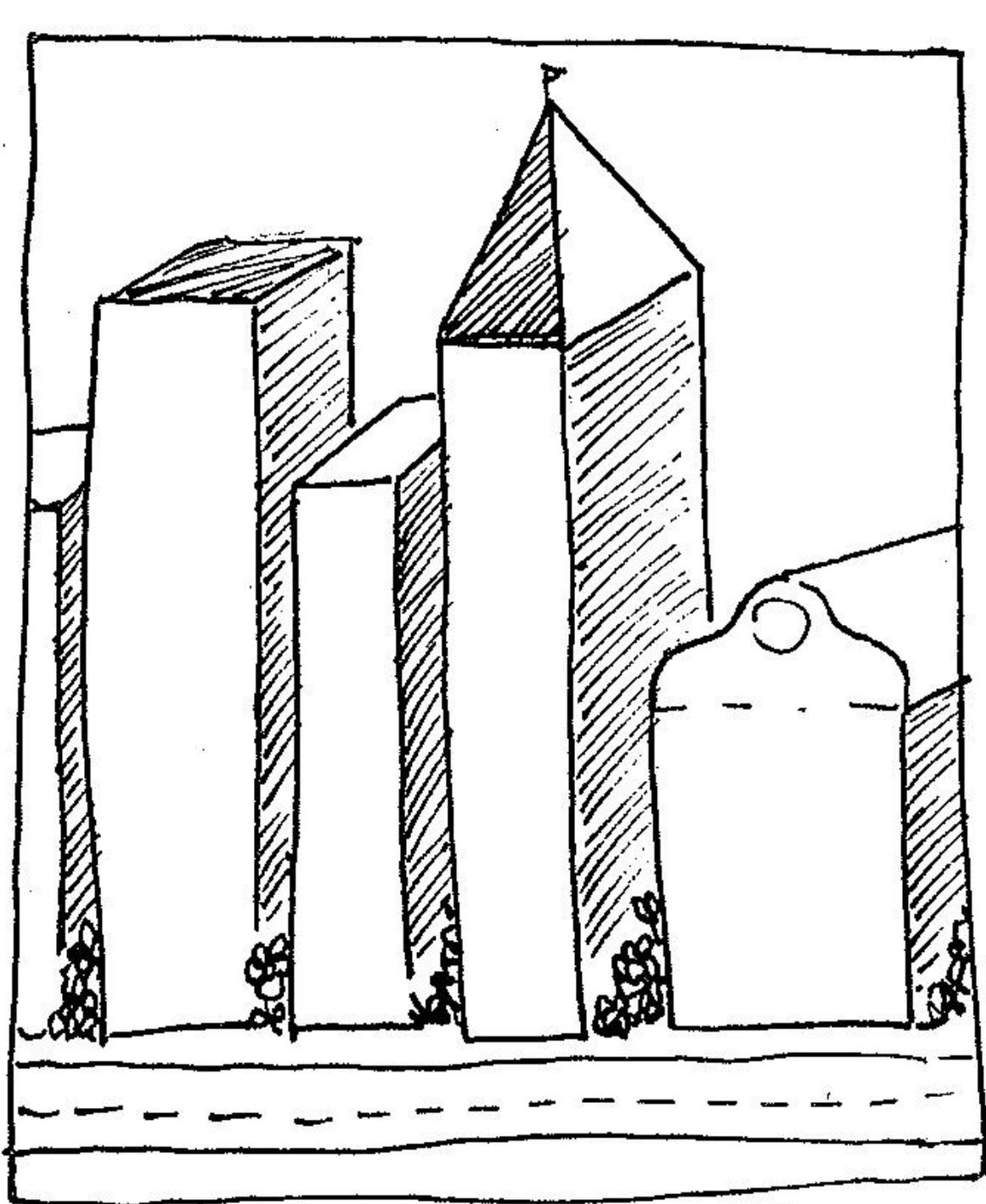
inoculants. The Australasian Tree Crops Sourcebook (1994; A\$12 from Granny Smith's Bookshop, P.O. Box 27, Subiaco, WA 6008, AUSTRALIA; fax 61-9-385-1612) is full of information on fruit, oil, and nut crops, and organizations of tree crop growers.

The Henry Doubleday Research Association (Ryton-on-Dunsmore, Coventry CV8 3LG, UK; phone 01203-303517; fax 01203-639229; e-mail [pharris@hdra.demon.co.uk](mailto:pharris@hdra.demon.co.uk); Attn. Dr. Phil Harris), a registered charity in the United Kingdom, makes available easily understood information and advice on tropical organic agriculture to farmers, NGOs, self-help groups, schools, and other organizations in developing countries, helping them function more effectively in their extension, demonstration, and education roles. The HDRA also assists groups in selecting tree species for their required purposes, providing technical and practical details for their cultivation and use. Where available, they may provide small quantities of tree and shrub seed for local evaluation. Lusume Services (P.O. Box 42, Magoye, ZAMBIA) has a variety of multipurpose and fruit tree seeds at reasonable prices. For the Latin American Bank of Forestry Seeds, write to CATIE Seedbank, Box 111, Turrialba 7170, COSTA RICA. The Endangered Species (P.O. Box 1830, Tustin, CA 92680, USA; phone 714/544-9505; fax 714/669-0740) catalog lists 140 kinds of bamboo and 105 palms (plants only). SETROPA (P.O. Box 203, 1400 AE Bussom, HOLLAND; phone 31/2152-58754; fax 31/2152-65424) has many tree seeds, with some legumes and grasses. Green Gold International (14071, Street 5, Prabhat Nagar, Dholewal, Ludhiana-114 003, INDIA; phone 91-1662-32326; fax 91-161-401513 or 91-1662-32120) specializes in seed and wax-sealed cuttings of neem; about 300 tree species are in their catalog.

Dr. Jean Hanson, head of ILCA's Forage Genetic Resources Section wrote, "The ILCA genebank holds about 12,000 accessions of a wide range of forage legumes, grass and fodder tree species. Small experimental quantities of seeds are available free of charge for forage research and development workers. It usually takes up to a month to fill seed requests." For large projects, they publish a catalogue in 3 volumes. Volume 1: multipurpose trees and large shrubs; Volume 2: tropical lowland forages; Volume 3: temperate and tropical highland forages. "ILCA also has a Herbage Seed Unit that can provide larger quantities of a limited range of species to begin local forage seed multiplication programmes. You may wish to mention our service in your newsletter so that readers can write to request seeds." We have always found the people at ILCA to be very responsive and open to helping development workers. If you are having trouble finding something, keep them in mind. (Note: in 1996, ILCA merged with ILRAD-Kenya to form ILRI, the International Livestock Research Institute. We hope these same services are still available. The address is P.O. Box 5689, Addis Ababa, ETHIOPIA.)

If you still cannot find what you want, the FACT Net (see Chapter 4 on Multipurpose Trees) has addresses of other commercial tree seed companies, including a two-page listing of tree seed companies in the Pacific. Remember to order well in advance of planting date, because tree seed companies often must fill orders from the next harvest.





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