EDN ECHO Development Notes

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Issue 100

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ECHO is a Christian non-profit organization whose vision is to bring glory to God and a blessing to mankind by using science and technology to help the poor.

Issue Highlights

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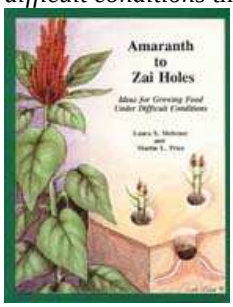
Issue Number 100!

After 27 years of publishing *ECHO Development Notes* (*EDN*), we have reached a milestone with this 100th issue. For this issue, we looked back over the previous 99 issues and selected some of the plants, techniques and perspectives that we believe have special potential to help you in your efforts to improve the lives of the poor.

Many ECHO staff members shared their "top picks." Compiling them has been a gratifying exercise in many ways, as we realize the depth and breadth of subjects that have been covered over the years. Because limited space allows only a brief summary, we point you to the relevant resources, especially our book *Amaranth to Zai Holes: Ideas for growing food under difficult conditions* that was based on the first 51 issues of *EDN*, and the issues published since (52 to 99). These and other resources are posted on our website. In this issue, they will be referenced by *AZ* followed by the page number of the article, or by *EDN* plus issue and page number (e.g. *EDN* 70-3). Technical Notes are abbreviated as TN. *EDN* is available in Spanish from Issue 47 and in French from Issue 91. Selected articles from *AZ* have been translated. We have prepared a special 100th issue section on our website. If you read this issue on-line, the relevant articles (and sometimes additional material) are available by simply clicking on the hyperlinks in issue 100.



Those who do not have the materials we refer to and who have no or limited access to the Internet, can write us for more information on any particular article. Please mention if we can send the documents you request by email or if you need paper copies.

We hope that you will enjoy this issue, and that it will bring new ideas to help you provide more options for the poor, to give them a future and a hope.

The editors wish to thank Tim Motis and Danny Blank for writing and editorial help, and Bob Hargrave for setting up the special web interface.

Farming/Gardening Techniques

Above-ground or Rooftop Gardens. For 25 years, ECHO has promoted several methods for growing vegetables above ground, particularly methods well suited to urban settings on rooftops, concrete slabs, or in areas where gardens may benefit from being out of the ground due to factors like flooding; roaming chickens, iguanas, or goats; extremely poor or acidic or alkaline soil; or simply the ease of working at gardens that are raised to waist or chest height. We have seen above-ground gardening methods used from rural Haiti (where raised tires kept chickens from ruining gardens), to the rocky soils of the Bahamas, to very urban settings like St. Petersburg, Russia, where rooftops may be the only space available for growing.

Mark Hare, currently working in Haiti, recently commented that tire gardens are the most popular technique he has ever been involved with, even in a rural area. The area is constantly stripped of

Cabbage and lettuce grown hydroponically on a piece of old carpet in ECHO's urban gardening area.

all of its old tires. Gardeners use them primarily to start seedlings for transplants. The seeds and tender seedlings are less likely to be destroyed by ants, snails, chickens, or goats.

All the methods use recycled materials and are exceptionally light weight. You will find extensive details on our website about the many methods for above-ground gardening that ECHO has developed. A TN is available.

Farming God's Way (FGW). ECHO farm manager Danny Blank says, "Of all the methods I have seen promoted over the years, this is one of the more exciting approaches to sustainable field crop farming. FGW combines excellent life-changing principles with sound land care practices. There are marvelous testimonials of its success in southern Africa and we have seen its benefits on ECHO's own farm." Learn about FGW from the website www.farming-gods-way.org; *EDN* 98; and the DVD series we sell at our on-line bookstore (www.echobooks.org).

SRI (System of Rice Intensification) for major increases in yield with fewer inputs. Briefly, SRI involves transplanting rice seedlings carefully at a very young stage, with a single plant per station, at wider spacing (30 cm X 30 cm and greater), and grown under non-flooded conditions. The increased spacing and air in the soil result in greater tillering and yield. Although initially it can involve extra work, as time devoted to planting and weed control is usually greater, there are many reports of incredible yield increases with SRI. Yet there continues to be skepticism on the part of some in the scientific community. Some scientists argue that the data for SRI simply don't support its claims of outperforming the conventional method of growing rice, assuming that proven "best management practices" are used. ECHO plans to have an in-depth look at SRI at our December 2008 conference followed by an *EDN* article in 2009. *EDN* 70; also see the SRI website at ciifad.cornell.edu/sri/.

Dryland Farming Technical Note. Bob Hargrave worked 18 years helping small-holder farmers in drought-prone regions in Kenya before joining ECHO's staff. He says that he used this TN a lot while in Kenya. You will find many practical suggestions and insights in this document if you work in an arid part of the world.

Green manure/cover crops (gm/cc's). ECHO considers gm/cc's to be a subject that almost anyone working with small-holder farmers needs to know something about. Whether used as an intercrop (growing with the main crop) or in rotation (planted after the field crop has been harvested), benefits can be impressive. Soil fertility is increased; need for fertilizer is decreased; and leaves of some gm/cc's are good feed for livestock. All gm/cc's can contribute to a mulch layer that keeps the soil cool and helps it absorb water, so that erosion is reduced. Weeds are also suppressed and a host of beneficial soil life arises that is important for plant health.

Gm/cc's have become a very important part of short- and long-term fallows between cropping cycles on ECHO's farm. We have learned to depend on a number of these species for improving and covering our soil. Some of the main species we use and recommend are lablab bean (*Lablab purpureus*; varieties 'Rongai' and 'Highworth' are favorites for an annual cover crop), velvet bean (*Mucuna pruriens*) and jack bean (*Canavalia ensiformis*).

During the 1990's, Roland Bunch played a major role in bringing exposure to the significant impact gm/cc's have played for farmers, particularly in Central America. ECHO's Technical Note "Green Manure Crops," written by Roland Bunch and our own staff, highlights the major gm/cc's used in the tropics. (See *AZ* and the TN on our website). The final two pages of the "Green Manure Crops" TN features a small booklet called *The Poor Man's Plow*, by Lewis Baker, which creatively describes the significant contributions and advantages gm/cc's have for small-scale farmers in the world. Also see *EDN* 74.

SALT (Sloping Agricultural Land Technology) with emphasis on forage and animal production. This method is designed to allow crops to be grown even on steep hillsides with minimal erosion while at the same time

The figure at the left shows an abandoned hillside at Rancho Ebenezer in Nicaragua, before the introduction of the SALT technique. The figure on the right shows the same hillside, about three years later. Photos used with permission from Mark Hare.

increasing soil fertility and providing fodder for livestock. Rather than controlling erosion with rock terraces or ditches, SALT relies on rows of vegetation. Trees and shrubs with the ability to grow very closely together and to resprout when cut back are planted only inches/centimeters apart on the contour of the land. They are never allowed to grow too tall. Pruned branches are either left in the field as mulch or fed to animals, with manure returned to the field. After a heavy rain, the water is slowed down as it passes through the barrier. Many of the soil particles carried by runoff water are dropped, resulting in a gradual buildup of a somewhat flattened area on the uphill side.

ECHO farm manager Danny Blank says, "I had heard for years about the SALT method, developed by Harold Watson at the Mindanao Baptist Rural Life Center in the Philippines. In 2001, we implemented it on ECHO's own demonstration farm. I liked the success we experienced with legume tree hedgerows, especially when prioritizing the use of prunings as animal feed rather than mulch for crops. But it was not until I visited Rancho Ebenezer in Nicaragua in 2004 and 2007 and saw SALT being used on a large scale that I became convinced that this is one of the better methods for sustaining and improving agriculture production on hillsides, especially where rainfall is usually adequate for the crops being grown between the hedgerows. ECHO offers a TN on the subject and covered it briefly in *AZ* 139, but one can also find an excellent review in the FAO document *Forage Tree Legumes in Tropical Agriculture*, highlighting how the soil conserving benefits were realized as economic gains to Filipino farmers. Find publications about SALT at www2.mozcom.com/~mbrlc/publications.htm.

Small-scale nurseries to contribute to agriculture transformation on the small-scale farm. Danny Blank shares, "Enabling farmers to move toward more diversified and perennial-based production means there is a need for large quantities of healthy seedlings and vegetatively propagated plants. Whether a farmer has his/her own nursery or there is a local nursery business, having access to quality plants can make all the difference for making substantial improvement on the farm. As an example, in 2001, ECHO moved its farm to an adjacent property. We planted well over 100 species of perennial fruits, timber, forage, and general food species, most of which came out of our own nursery. I don't know how we could have done it without a safe, protected way to produce quality plants." A TN is underway on this subject and will be posted online when ready.

Getting a handle on organic fertilizers. Manure, compost, worm compost, EM (Effective Microorganisms), mycorrihzae, humic acids, and microbial and nutrient based-teas constitute a number of organic materials used to increase crop production and health. Chemical fertilizers are becoming increasingly expensive and out-of-reach for small-scale farmers. For centuries farmers all over the world have used manures, compost, and biofertilizers. However, much of the information about organic fertilizers is undocumented or anecdotal, coming from casual observations rather than thorough investigation. Fortunately, this is changing. We need to get a handle on the "best management practices" for small-scale farmers in the realm of organic fertilizers, so that farmers can reliably produce quality fertilizers without expensive inputs. We at ECHO are increasingly taking a hard look at this, through experimentation on our own farm; researching; and learning from our network members, as well as other folks and institutions. See *EDN* 96-1. We intend to publish more information on recommendations, recipes and rates for organic fertilizers.

Mulch, mulch, mulch. Keep the soil covered. At ECHO, the soil around nearly all our plantings—vegetables, fruits, grains, root and tuber crops, even forestry plots—is covered with organic matter. Whether through crop residues, a permanent cover, a slash and mulch green manure, a cut and carry mulch (for example, vetiver grass stems), or wood chips from tree trimming companies, we make a strong effort to not leave bare ground. This has been a practice for decades at ECHO, foundational to success with our own plantings. It was confirmed and underscored from the very positive reports shared by Roland Bunch from Central America on the enormous importance of keeping the soil covered in the tropics. Our observations and experiences on the ECHO farm and in network visits to many regions around the world increasingly confirm to us that mulching is a critical aspect of farming in the tropics. When all else fails, mulch. For more on the importance of mulch, see *EDN* 58-1, 74-1 and 96-1.

Forage banks for animal production. At ECHO, we primarily feed our animals using a "cut-and-carry" system. Densely-planted perennial forages can substantially improve animal production, especially for small land areas.

For ruminants, some species we use extensively include *Calliandra calothyrsus* (*AZ* 109), *Leucaena*

leucocephala (*AZ* 110, 139, 156, and 220; *EDN* 57-6 and 99-7), and *Gliricidia sepium*. For ruminants and some non-ruminants that can digest cellulose (rabbits and fish), we use Napier grass (*Pennisetum purpureum*), *Desmodium rensonii* (widely used in hedgerows as part of SALT in the Philippines), nacedero (*Trichanthera gigantea*), mulberry (*Morus* spp.), *Hibiscus* spp, and willow (*Salix* spp.).

Fruit for every season. Danny Blank says, "There are many perks to working at ECHO, one being that on all 365 days of the year, one could go out and eat from a minimum of five different fruit species—and that is definitely the minimum! With around 100 species of warm climate fruits planted around the farm, some bearing for several months at a time, ECHO is both diverse and productive when it comes to fruit. The striking lack of fruit diversity represented on homesteads and farms sadly amazes me when making network visits overseas. The tropics boast an incredible diversity and abundance of fruit species. There are so many options that contribute to food, incomes and overall quality of life for millions of families around the world. And fruits provide more than food or income. Fruits bring a simple quality to life that is hard to describe—there is nothing quite like sitting down to a bowl of lychees, grapes, or slice of sweet mango. ECHO works hard to maintain a diverse collection of fruit species that serves our network well. For example, some of the traits we look for in cultivars include early and late bearing seasons, high production, resistance to diseases, wide adaptability, ease of management and dwarfing. We also look for fruit varieties for specific environments such as high altitude, drought, high salinity, high rainfall and flooding. We encourage you to visit the ECHO campus or write to us for help in suggesting ideas for improving fruit resources in your area." Link to information on ECHO's website by clicking on "Tropical Fruit Information." One of the most used books at ECHO is *Fruits of Warm Climates* by Julia Morton. The book or CD can be purchased from ECHO's bookstore or read online (see link in the "Books" section later in this issue).

Impressive reforestation by taking advantage of the "Underground Forest." Farmer Managed Natural Regeneration (FMNR) can potentially have an enormous impact on the environment and the welfare of whole countries. This single activity can quickly and cheaply transform communities, the environment and the economy. On cleared land where native tree stumps have not been uprooted, an extensive "hidden forest" exists. Each year, these stumps sprout multiple shoots. Traditionally, the sprouts are slashed and burned along with other vegetation. However, with culling and pruning, selected stems from this regrowth grow rapidly. FMNR is widely used in Niger and nearby countries; in Niger, more than five million hectares (50,000 km^2) are under FMNR management. See *EDN* 58-4 and 90-3; other FMNR information is also on ECHO's website in English and French.

Experimentation as a way to reach beyond our immediate situation. Most of us have a vision that exceeds our own present circumstances and knowledge. ECHO encourages our network members to be experimenters. In fact, many of the things mentioned in EDN are things that have worked in one location and might work for the farmers where you live. But the only way to know for sure is if you try the technique or if you plant a packet of seeds. When you do, you have become an experimenter, doing valuable research for your area. You will be adding "tools" to the "toolbox" of locally-proven agricultural innovations to share with local farmers. In fact, you can involve them in experimenting, too.

Three ECHO documents discuss how development workers can make a difference by experimenting with new ideas. In an *EDN* 81 article titled "Toward More Fruitful Agricultural Experimentation," Mark MacLachlan shares how experimentation shaped the nature of his agricultural work in Ethiopia. A TN, "The Small Farm Resource Center," describes how ECHO would advise an organization wanting to add a somewhat more formal experimental component to its work (also see *AZ* 41). An article called "Formalizing Your Research" by Edward Berkelaar (also in *EDN* 81), explains how to do research at a higher level of sophistication.

When tomatoes fail to set fruit or form large fruits. These are common problems for gardeners from the tropics. If you have a tomato plant that is healthy and flowering but not setting fruit, the reason is likely related to temperature. Both absolute temperatures and the difference between day and night temperatures (diurnal variation) affect tomato fruit set and quality. Realizing that published guidelines vary, we suggest the following requirements:

1. Daytime temperatures below 40°C (104°F) and optimally below 33°C (92°F). Nighttime temperatures below 26°C (79°F). Fruits that do set outside these ranges are often so badly damaged or misshapen due to poor pollination that they are not marketable.

2. Diurnal variation greater than 5.5°C (10°F). Tomato plant growth and fruit set is reduced in areas where the difference between day and night temperatures is less than 5.5°C (10°F). As an exception, a very high diurnal variation, as might occur in a desert or high in the mountains, can apparently overcome some of the above effects of high temperatures.

Heat-tolerant varieties have been developed which can extend the range a bit. Cherry, plum, and other small tomatoes seem to be less adversely affected by temperature extremes, which is why those types are often the ones found in local markets. See ECHO's seed listing on the web or search the Internet to find them. *EDN* 53-3.

Making bone meal fertilizer. Fertilizer has always been unaffordable for many smallholder farmers, but the dramatic global increase in fertilizer prices this year has made it even more difficult for farmers to increase soil fertility. Bones were used as fertilizer in England as early as 1653. In *EDN* 55 we featured ways to make a quality phosphate fertilizer from bones, called bone meal.

An inexpensive low-technology method of making bone meal is called "trench-firing." The meal is equal to the best quality steamed bone meal, which is often imported at high prices. A fire is built in a trench a minimum of 60 cm (2 feet) deep. A grid is laid across a shelf dug some 15 cm (6 inches) below ground level along the trench, and bones are piled on top of the grid. This simple method ensures that large logs may be used for firing and that the heat is concentrated so that the required temperature is reached more quickly.

The firing process achieves three aims: (1) it sterilizes the bones; (2) it burns off all the fat, blood vessels, marrow etc.; (3) the "calcined" bones are so soft that they can be pounded easily with a mortar and pestle.

Make your own salt block for livestock. Bone meal has another use. You can overcome mineral deficiencies in cattle by making your own cattle lick or mineral block, using bonemeal as the source of phosphorous. Bonemeal can be fed alone to cattle, but it is better to enrich it by adding other trace elements that may be lacking in your particular area. Plants grown on soil deficient in phosphorous will themselves be deficient in phosphorous. The livestock that eat the plants may in turn have low blood phosphorus levels, causing many health problems.

Salt licks can provide the minerals that are often lacking for livestock. You can make your own out of local ingredients. Some farmers and community groups started producing salt licks for sale in their village as an income-generating activity. Farmers in Kenya could not afford commercial salt licks, but when some farmers' groups started producing local salt licks, villagers began buying them. (From *Baobab* 28, March 1999, summarized in *EDN* 65).

The simplest recipe for making a salt lick comes from Ibrahima Diallo of Veterinarians without Borders. The ingredients required are bones, salt and clay. Pound and sift clay from a termite mound. Then mix two parts rock salt, four parts bonemeal and one part of termite clay and add enough water to create a paste. The paste can then be molded by putting it in wooden boxes, in wide metal bowls or calabashes with holes in them (for aeration), or in big tin cans lined with plastic bags (remove the salt lick when dry). Once dried, put the salt licks out for your livestock.

More information is found in *EDN* 65 and on a website (www.dsimb.inserm.fr/~debrevern/OTHER_PB/611_blocks.html) detailing steps to make a protein block.

"Micro-placement of fertilizer" to dramatically increase yields with less fertilizer. Farmers in Niger used bottle caps to distribute tiny amounts of fertilizer in each planting hole. Coca cola bottle caps hold 6 grams (0.2 oz) of fertilizer, and one capful was used for two to three plants. Total fertilizer use was one-third or less per hectare than is used in Europe. Despite drought conditions, farmers who used this technique harvested 50 to 100% more than those who did not. Another organization in Niger arranged for 67 farmers to each plant half a hectare in the traditional manner (with one person digging the hole and a second dropping seeds and covering them) and the other half-hectare using micro-placement of fertilizer (one person digging, one dropping a bottle cap of fertilizer and one planting the seeds and covering them). The yields of the fertilized plots were twice those of the unfertilized plots. The NPK fertilizer in the planting hole gives plants a quicker start earlier in the season, giving a root system that can better pull water and nutrients from the soil. For more information, see *EDN* 84-3 and a description on the web (www.icrisat.org/satrends/aug2002.htm#4) of research by ICRISAT on fertilizer placement.

Develop your own corn (maize) variety. Bob Short in Mexico teaches farmers to improve their own open-pollinated (not hybrid) corn varieties. The people already select the best ears for seed, but the selection is made from a pile after the harvest. Selection based on ear size alone can cause more problems than you might think. A national contest in the Midwest USA for the best ear of corn had quite a surprise when sponsors collected 25 ears of the best show corn and 25 of the poorest. The highest yield came from an ear that no corn-show judge would look at twice. As a whole, the highest-ranked show ears produced less than those that ranked lowest.

Bob begins by thinking through what traits he wants to select. He has a mental picture of what a good corn plant would be like for his area. "Our method of selection is simple. First we de-tassel the poor plants before pollination. This ensures that pollen will come from the better plants only. Then we select the ears to be kept for seed in the field. We take from the best plants which produce a good ear, taking into account the quality of the roots, stem, disease resistance, leaf area, etc." The important difference in this method is that good ears come from plants that are also known to be good.

Dr. David Unander shared, "Plant breeding texts and research suggest a minimum of 30 plants is needed to avoid serious inbreeding, but much more is better. The extent of inbreeding is a function of the percentage of the population saved and will increase substantially if much less than 10% of the harvest is saved and mixed in the seed bin." See *AZ* 77 for more information.

Is alley cropping right for your situation? This agroforestry technique has been widely promoted in agriculture development programs throughout the tropics. Alley cropping (AC) is the practice of growing food crops in alleys between hedgerows of trees or shrubs, which are regularly coppiced (severely pruned). Prunings are placed on the soil as mulch around the food crops, or they are used to feed livestock and to provide firewood.

Typically an AC system consists of trees planted 20 to 50 cm (8-20 in) apart in straight or contoured (if on a slope) rows with 4 to 6 m (13-20 ft) between rows. Alley width and in-row tree spacing can be adjusted depending on factors such as average rainfall and crop selection. The SALT technique described earlier in this issue is a special adaptation of AC.

An AC system can improve soil health and fertility as: 1) mulched prunings decompose; 2) manure from any animals

that ate the prunings is brought back into the field; 3) trees with roots extending below crop root systems bring nutrients up from the subsoil to where they can be accessed by the crop; and 4) nitrogen-fixing trees add nitrogen to the soil. In dry climates, AC may give no net benefit or may actually decrease yields. This is due to too much competition for water between tree roots that grow into the alleys and the crops being grown in them.

In timing the pruning of hedgerows, whether for use as forage or mulch, a general guideline is to cut the trees by the time they are 3 m (9.8 ft) tall or the stem diameter is more than 1 cm (0.4 in). Prune the trees back to a height of 1 m (3.3 ft) or less. Delays in pruning may result in "woody" mulch that does not decompose well. Obviously, AC is a labor-intensive venture not suited to farms with a labor shortage.

Suitable trees for AC are those that are: 1) fast growing, producing much biomass; 2) able to coppice well (resprout after repeated prunings); 3) a source of useful byproducts (e.g. firewood, fodder, stakes); 4) high in leaf protein (nitrogen); 5) compact in terms of growth habit, minimizing shade to the crop; and 6) deep-rooted with few shallow, lateral roots that tend to compete with the crop for nutrients and water. Seed-grown trees are more likely to develop a taproot than are trees started by cuttings, which tend to develop extensive lateral root systems.

Some commonly recommended tree species are *Leucaena* spp., *Calliandra calothyrsus*, *Gliricidia sepium, Senna siamea*, *Sesbania sesban*, and *Acacia* spp. Often one may find that a native species is best-adapted to local conditions and pests. *EDN* 82 and 84; Agroforestry TN.

Mud dip for roots when transplanting. Eddie Visser in Guatemala wrote, "While transplanting citrus and leucaena seedlings into the ground, the soil would sometimes crumble off, leaving the roots of the transplant exposed. When this happened we dipped the roots into a mud solution, so that the mud adhered to the roots. Almost all the transplants we did this to are still living. The ones we did not do this to died."

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

Sweet potato yield as influenced by intercropping. In many instances, sweet potato is intercropped with other crops such as cassava or maize. You might wonder, "How does intercropping influence sweet potato yield?" This question was addressed in *EDN* 58-2 and *EDN* 60-7. The answer, as is often the case in science, is "It depends." Scientists at the University of Ibadan in Nigeria (*Tropical Root and Tuber Crops Bulletin, March 1997, Vol 9, #2, pp. 6-8*) found that fresh tuber weights of a local cultivar were reduced 26% when intercropped with cassava and 77% when grown with both cassava and maize. Leaf (good for animal feed) production, on the other hand, *increased* with a local cultivar and *decreased* with an improved cultivar. Why might sweet potato leaf production be increased by intercropping? The answer seems to lie in the fact that stress increases sweet potato tuber production. As long as the intercrop does not compete too strongly with the sweet potato variety being grown, shade underneath the cassava or corn crop canopy may be less stressful than full sun to the sweet potato plants. This information could be helpful in evaluating the performance of sweet potato cultivars under various cropping scenarios.

Helpful insights on sawing lumber from tropical trees. ECHO interviewed Glen Munro, a man with considerable experience sawing tropical wood in various warm climate countries. Here are a few excerpts from the interview.

It is very difficult to saw many species of eucalyptus, especially if the logs have not been dried. While sawing, the board curls and also sometimes twists. You can get around this problem by girdling (removing bark around) the tree and letting it stand for at least 18 months. Now when you cut the boards they will be as straight as any.

…Coconut "wood" is used where strength is not needed, especially as siding of buildings to shed water. You must let the dead tree dry a year before cutting.…You can saw wood shingles that will make buildings much cooler than those with metal roofs. If you choose local weather-resistant woods, the roofs should last about as long as metal roofs. *EDN* 60-1.

Perspectives and Insights

"After Ten Years in Haiti, Have I Done Any Good?" This article by Wayne Niles was based on a talk he gave at an ECHO Agriculture Conference. Niles shared about four different projects he had introduced in Haiti (rabbits, appropriate technology, poultry breeding, and micro-irrigation), and evaluated the results. Listening to someone with years of experience in development work evaluate his own successes and mistakes provided a unique perspective on efforts to introduce new options for the poor. *EDN* 79-1

Good soil under crop residue and mucuna mulch, Honduras.

The Importance of Life in the Soil. ECHO farm manager Danny Blank says that the principles in *EDN* 96 "revolutionized the way I look at the land and understand the impact agriculture practices have on the overall health of soils." The principles are

summarized well in the title of a useful on-line FAO publication: "The Importance of Soil Organic Matter—Key to drought-resistant soil and sustained food production." (ftp.fao.org/agl/agll/docs/sb80e.pdf). We know the consequences of poor farming practices in terms of poor production and continued poverty. Now, armed with greater understanding of why such practices result in land degradation, we are better equipped to conform farming practices to those that increase soil organic matter and soil life. *EDN* 96-1.

"Selecting the Best Plants" Technical Note. Bob Hargrave says, "This is a document I referred to a lot while I was working in Kenya." The "Selecting the Best Plants" TN is newly updated and now also available in French and Spanish. All versions are on our website.

Helpful advice about managing people. We have met a few thousand people who have moved to another country to work with the poor. Many envisioned themselves giving practical help one-on-one, but now find that they have been asked to spend part or all of their time managing people, organizations and projects. Universities offer degrees in management, but the people who go to work with smallholder farmers rarely have had any training in management. Their work is even more challenging because they are working within at least two cultures.

We asked an experienced company leader, Calvin Yoke, to discuss this topic at the ECHO Agriculture Conference in 2003. It touched such a felt need that we used it to write an article for *EDN* called "Management Can be Learned." Calvin Yoke wrote, "The area of management may seem foreign to many agricultural development workers, but good management can be an effective ministry. Most people spend the bulk of their hours under someone's management. There is no greater opportunity than that provided by management to make a positive impact on the world and on the people that you supervise." *EDN* 82-1.

How Can ECHO help you be more effective in your work?

ECHO is located on 49 acres (19.8 ha) in subtropical southwest Florida. We have the largest collection in the United States of plants useful to smallholder farmers in warm-climate countries.

You already know about *EDN*. People working to help the poor can apply to be a "member of our network" by requesting an application. *EDN* is available in English, French and Spanish. We normally send a paper version in black and white or an email version that has no photos. Full-color pdf issues are available on our website.

We try to answer your questions. Several staff members, called the "Technical Response Unit," spend a considerable amount of time researching replies to problems or questions from our network. Staff and people studying at ECHO make heavy use of our specialized library, which contains thousands of books and other publications including many that are out-of-print or hard to find.

ECHO's Bookstore sells books selected with development workers' needs in mind. We doubt if there is a comparable collection elsewhere in this country. You can read about and order books at www.echobooks.org.

Appropriate Technology. The term "Appropriate Technology" (AT) refers to helpful technologies that are appropriate to the technical skills and income level of a given community. You may be able to introduce an innovation that benefits your community almost immediately, as AT does not typically require lengthy experimentation (as is necessary before new crop introductions, for example). ECHO's AT staff have assembled working models of many technologies, to demonstrate pumping, treating and storage of water; alternative fuels and improved cook stoves; solar food dryers; presses to get oil from seeds; soil-cement brick making machines; etc. ECHO's helpful Appropriate Technology Guidebook (with pictures of some of the best models we have found) is on our website and has been translated into French and Spanish. Look for more AT articles in coming issues of *EDN*.

Intern Program. ECHO hires eight interns each year (two every three months) for one-year assignments. Applicants must either be US citizens or already have permission to work and be paid in the USA. Interns have a college degree, a strong interest in improving the lives of small-holder farmers in developing countries, and the quality of Christian life and character that would make them appealing to organizations with an agricultural component to their ministries.

As they work, interns benefit ECHO while gaining experience with an astounding array of tropical plants, agricultural techniques, and appropriate technologies that have potential to make an impact on the world. Each intern has responsibility for an area of the Global Farm in addition to either the seed bank or fruit tree nursery. ECHO's experienced staff provides mentoring, training, and encouragement. Positions begin in January, April, July, and October, and candidates should apply 6 to 12 months before the position date they are interested in. Interns receive a stipend, housing, and health insurance. For more information, see www.echonet.org, or contact Beth Doerr, the Coordinator of the Intern Program, at bdoerr@echonet.org.

Study Program. ECHO welcomes visitors to work and study with us. These "students" are given the opportunity to craft their own program of study including hands-on experience on the farm, resources in our library, and interaction with ECHO staff. Some participants want to explore the possibility of Third World agricultural development as a career opportunity, and some have received credit from the university they attend. Others, already doing development work overseas, research topics of concern related

to their own work. Download an application from www.echonet.org or contact Rhoda Beutler, the Educational Programs Coordinator, for more details. rbeutler@echonet.org.

ECHO hosts a three-week course called "Tropical Agriculture and Missions." Three college-credit hours are available through the Au Sable Institute for Environmental Studies. The course provides an overview of the important plants, concepts, and techniques involved in tropical farming systems. It is typically held for three weeks from mid-May to early June. Register at www.ausable.org.

ECHO is not able to assist non-US citizens in getting a visa to visit the USA. But citizens of other countries are welcome to apply for the "study program" if they can get themselves to this country. A few times there has been a misunderstanding when a citizen of a developing country comes to ECHO to learn "modern farming techniques." ECHO does not teach modern farming techniques. We emphasize very low-technology, low-cost techniques for the small-holder farmer.

ECHO's Agriculture Conference is held every November or December at ECHO. There is a Christian theme to the conference, and usually some sessions consider the relationship between the technical side of agricultural development and spiritual issues, such as church planting or discipleship. But most sessions are of a more practical, technical nature. We welcome delegates without regard to religious beliefs. Pre-registration is required.

Workshops. In addition to ECHO's conference, we offer several workshops: "Agricultural and Nutritional Options for People Living with HIV/AIDS" happens in early December. This workshop is designed for the development practitioner who wants to learn more about plants and ideas that are relevant to a community affected by HIV/AIDS. ECHO staff share practical information about high-yield, low-maintenance plants that thrive in harsh conditions (such as moringa, chaya and amaranth) as well as relevant techniques and farming systems. "Health, Agriculture, Culture, and Community" is a 35-hour workshop for health professionals and others working in holistic ministry. This workshop addresses community health issues and cross-cultural communication, and includes 10 hours of practical agricultural ideas that relate to overall health. The primary instructor is Dr. Daniel Fountain, who spent his career in medical outreach in the Democratic Republic of Congo. Applications are available at www.echoevents.org.

ECHO's seed bank specializes in seed for potential new crops or special varieties of existing crops. Many of you have requested seeds in response to the "From ECHO's Seed Bank" portion of *EDN* articles; we seldom write about a plant unless we are ready to send a small trial packet if you wish to evaluate the plant. But you may not know about the online list of crop species carried in ECHO's seed bank. We have an extensive seed listing posted on ECHO's technical website. Find "Seed Bank" on the left side of the home page of our website. Content under the "Seed Bank" heading is grouped by categories such as "Legumes" and "Nutrition and Income." To be able to see all the species we have at a glance, find "List of Crops in Seed Bank" and click on "By common name" or "By scientific name." If you have questions about who can order seeds and how to go about requesting seed packets, we invite you to find the "Information" category and click on "Seed Bank Policy."

As a reminder, ECHO's seed bank contains a wide range of species and varieties of underutilized food plants likely to grow well under difficult growing conditions. We provide small packets of seed with which to experiment. It is expected that if the crop succeeds, you will save and multiply enough seed for your project needs. If larger quantities are needed, we may be able to put you in contact with bulk suppliers or commercial companies. Network members may request, free of charge, one packet each of up to 10 varieties of seed. A charge of $4.00/packet applies to additional packets beyond the first 10 packets requested each year. If you receive a mailed copy of *EDN*, you are already part of our network. If you work in the area of agricultural development and are not yet a member of our network, you can become one by filling out a form on our website (www.echotech.org; click on "Seed Bank Policy" to find a link to our network registration form).

Inside ECHO's climate-controlled seed bank.

ECHO's website has an enormous amount of agricultural information. ECHO's technical website (www.echotech.org) contains a wealth of information on small farm tropical agriculture. Our publications, including *Amaranth to Zai Holes*, back issues of *EDN*, and Technical Notes, are all online. Some documents are also available in French and Spanish (including *EDN* in French from Issue 91 and in Spanish from Issue 47). We are actively working to increase the number of documents on our website in these languages. Our seed catalog is online, as is our bookstore. We also have a section for "Links" that take you to valuable information beyond our own website. If you have not checked out ECHO's website lately, we urge you to do so!

Underutilized Food Plants

The National Academy of Sciences in the United States has published a series of books with titles like "Under-exploited Plants with Promising Economic Value" or their "Lost Crops" series on African and Andean crops. These had a great impact on the thinking of ECHO. Even before publishing *EDN* Issue 1, we had begun work establishing a "user friendly" seed bank of many of these plants. Our goal from the start has been to enable members of our network to not only read about promising plants that have not been grown in the countries where they work, but to also get free trial packets of seed (see information above, about ECHO's seed bank) so they can evaluate the plants' potentials themselves. If farmers are interested, they can save their own seed. The plants below are some of the ones we consider "underutilized." Some others are included elsewhere in this issue.

Perennial Underutilized Crops

The importance of perennials for extending the season. The small farm, particularly in the tropics, is one of the most dynamic, complex and potentially sustainable settings for supporting and prospering life. Yet it is often where the greatest suffering occurs. Often farmers in the tropics do not take full advantage of the unique opportunities offered by 12 months of fairly intense solar radiation and heat. Such a climate allows and favors systems, trees, and crops that can capture this year-round productive potential.

A strong dependence on perennial crops can greatly extend the growing season, reduce labor inputs, and provide sustained, long term food security and profitability. Examples include coppicing woodlots for on-site continuous wood production, fencing to enable diversified production free from ranging animals, perennial legumes, perennial edible greens, diversified fruit and nut production, and perennial forages planted at high density for increased animal production.

When farmers in the tropics move toward year-round production through perennial-based agriculture, farming is not limited to the rainy season. Furthermore, production of both calories and protein (on a per acre basis) in the tropics can far exceed farms in temperate zones. A great short article highlighting the enormous importance and role perennial crops play in tropical farming systems can be found at www.mekarn.org/sarpro/preston.htm.

Perennial greens for year-round nutrition. Use of perennial greens has been and continues to be one of ECHO's key approaches to providing options for the poor. We introduce our visitors to a great collection of perennial species that boast edible parts, especially leaves. As the saying goes, "plant once, harvest for years." These species are prominently featured on our farm. They are particularly important for people who are elderly, handicapped or ill (e.g. people living with HIV/AIDS), since they are an excellent source of nutrition—especially vitamins and minerals—and can be grown with minimal care.

These garlic chives at ECHO have been growing in the same tire for over 14 years!

In addition to the plants outlined below, other major species for perennial greens are edible hibiscus, basket vine, and garlic chives. We have had many reports from our network confirming the unique contribution of perennial greens to family health and food supply.

Moringa (*Moringa oleifera* and *M. stenopetala*), an excellent source of vitamins and minerals.

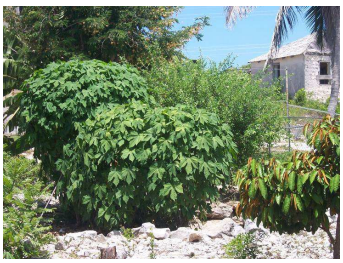
Moringa is still the most-requested seed in our seed bank. Of about 13 species of moringa, *M. oleifera*, native to India, is the most widely known. *M. stenopetala* is also quite well known and is noted for its drought resistance, being native to Ethiopia. Present in many parts of the tropics, it produces leaves, flowers, and pods, all of which are edible and nutritious. Most people in ECHO's network are interested in the leaves, which possess an abundance of vitamins (especially A and, when raw, C), minerals (notably iron and calcium), protein and antioxidants. The leaves can be dried in the shade and crushed in a mortar to form leaf powder. A highlight from a report by Lowell Fuglie with Church World Service ("*Moringa oleifera*: Natural Nutrition for the Tropics"; featured in *EDN* 64) reads, "One rounded tablespoon (8 g) of leaf powder will satisfy about 14% of the protein, 40% of the calcium, 23% of the iron and nearly all the vitamin A needs for a child aged 1 to 3. Six rounded spoonfuls of leaf powder will satisfy nearly all of a woman's daily iron and calcium needs during pregnancy and breast-feeding." Fuglie notes that boiling the leaves and discarding the water results in loss of nutrients.

Moringa can also be used to purify water. One crushed moringa seed kernel can treat 1 liter (1.056 quarts) of water. The seed powder, added to the water and stirred for 5 to 10 minutes, functions both as a coagulant (binding to impurities) and as an antimicrobial agent. Once the seed powder and impurities have settled to the bottom of a container, the clean water can be poured off. Moringa treatment—using either *M. oleifera* or

M. stenopetala—removes up to or more than 90% of impurities, including bacteria, but moringa-treated water should be treated further to make it completely safe from all pathogens. A simple follow-up treatment, featured in *EDN* 53 and 90-2, is solar disinfection (SODIS), an inexpensive and straightforward technique for disinfecting water. It involves filling transparent plastic bottles with clear water and exposing them to sunlight for two to six hours. The ultraviolet rays from the sun destroy harmful microorganisms. Bob Hargrave commented, "This is how we treated our drinking water [in Kenya] for about 8 years."

For moringa articles in general see *AZ* 11, *EDN* 69-7 and 96-7, and Moringa TNs. The French organization PROPAGE has established a moringa network and an incredible website, www.moringanews.org (in English and French).

Chaya (*Cnidoscolus aconitifolius* ssp *aconitifolius)*, an extremely nutritious and hardy source of green leaves. Chaya is sometimes referred to as tree spinach. The leaves are very high in protein, calcium, iron, carotene, and vitamins A, B and C. The leaves also contain hydrocyanic glycosides, which could cause health problems if the leaves were eaten raw. Boiling or frying the leaves for at least five minutes removes the danger (books say to discard the cooking water, which contains a small amount of cyanide).



The large chaya leaves are boiled and eaten, especially in Mexico and parts of Central America. They are also used to wrap tamales. At ECHO, the plant becomes an attractive shrub the height of a tall person, but it may grow as a small tree in the tropics. The petioles of some varieties are covered with tiny, stinging hairs that disappear after cooking, but that can be irritating. If these are present, wear gloves or place your hand in a sock when picking the leaves. (The variety ECHO has distributed since the mid 1990s lacks the hairs.) A USDA study in Puerto Rico reported that one can get higher yields of greens with chaya than any vegetable they have studied. Chaya is unique in that it is exceptionally resistant to the hot humid weather of our Florida summer and to extreme dry weather! Though it blooms frequently, chaya seeds are very rare. It starts readily from cuttings, which is how ECHO distributes it. Because of the plant's drought tolerance, cuttings survive well in the mail, even after weeks in transport. *EDN* 78-1 (now a TN); *AZ* 55; *EDN* 53-1.

Katuk (*Sauropus androgynous*) for an edible hedge. Katuk is a staple perennial vegetable in Borneo and Vietnam. It is often grown as an edible hedge; the leaves and young stem tips are eaten either cooked or raw and have a flavor reminiscent of fresh peas or peanuts. Katuk grows well in Florida, and has become one of the favorite salad greens of the staff at ECHO. Katuk does extremely well in hot humid conditions and can tolerate occasional flooding. Seed has low germination, so we propagate and distribute katuk by cuttings. (However, a network member who worked in Mindanao in the Philippines told us that in the hot, humid climate there, seeds sprout readily underneath plants.) Katuk is disease and pest resistant, tolerates most soils, and grows in sun or shade. For the best tender shoots and leaves, grow katuk in half shade and fertilize frequently. Keep it pruned to 3 to 6 feet, since it tends to grow straight up until it falls over. *AZ* 58; *EDN* 90-6.

Annual Underutilized Crops

Edible nutritious seeds and leaves from amaranth (*Amaranthus* spp). Amaranth is a versatile plant, with edible nutritious seeds and leaves. It is more drought tolerant than wheat or maize. Amaranth plants are well adapted to growing at higher temperatures, in bright sunlight, and in dry conditions. (It is a C-4 plant, for those of you who have studied botany). Amaranth is harmed by frost. It grows best between 21 to 28ºC, but can go as high as 35 to 40ºC.The highly nutritious amaranth seeds were a staple in the diet of the Aztec Indians in Central America.

Although the seeds are hardly bigger than poppy seeds, they occur in very large quantities, around 100,000 per plant. They contain protein that is nearly perfectly balanced for the human diet. The protein content is 13 to 18%, containing high levels of the essential amino acid lysine. Seeds also have high levels of calcium, iron, phosphorous, potassium, zinc, vitamin E, and vitamin B-complex. The fiber is very soft and fine, especially in comparison with wheat and other common grains, so it is not necessary to separate it from flour. Seeds are ground for porridge or flour; they may also be toasted, popped, flaked, or sprouted to use in cooking and baking.

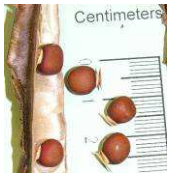
Globally, amaranth leaves are probably more widely eaten than the seeds. Leaves of any amaranth can be eaten (boil and discard the cooking water to remove oxalates), but those selected for vegetable use are more suitable for cooked greens. Vegetable types will not give enough seed to be used for grain. Flexible stems up to thumb size can also be peeled, cooked and eaten like asparagus. Amaranth plants may also be used as a forage crop.

ECHO distributes several species and varieties of grain and vegetable amaranth. Check the seed listing on our website for descriptions of these. *EDN* 91-1; AZ 75; also a TN.

Winged bean (*Psophocarpus tetragonolobus*). The winged bean has potential to be a perennial, though at ECHO

root knot nematodes are such a serious pest that we grow it as an annual. Winged bean produces edible leaves that can be cooked like spinach, edible pods that can be cooked like green beans if harvested when still green and flexible, edible dry beans that should be harvested after pods are brown and dry,

and edible blossoms that can be eaten raw or fried. Some varieties will produce edible tubers (e.g. Square and a day-neutral variety) when the plants are older. The tubers have up to 10 times the protein of a potato. Winged bean plants can be difficult to get started, but become quite prolific after a couple of months. Most varieties will not produce blossoms until days are quite short.



ECHO has special "day-neutral" varieties, however, that will produce regardless of day length. Winged bean is grown on a trellis, as the plant is a vigorous vine. Winged bean is a highlight on tours, and important for overseas visitors. ECHO's collection is larger than perhaps any other in the USA. More information can be found in *AZ* 270; 277 (cooking information); *EDN* 83-8; *EDN* 97-6 and our on-line seed catalog.

Celosia (*Celosia argentea*), also called Lagos spinach or Quail grass, is a low-maintenance leafy vegetable that is easy to plant, grows in most climates and soils, withstands drought and heat, and has few problems with pests and disease. It is easy to prepare, highly nutritious and tastes good. The plant has attractive flowers. Note that it also produces large quantities of seed, which can make it a pest. *EDN* 94-6 (expanded in a TN); *AZ* 65.

Quinoa (*Chenopodium quinoa*). Seeds from quinoa are a popular, nutritious food that is grown at high altitudes in the Andes Mountains in South America. The seed has an exceptional balance of protein (16-23%), amino acids, fat, oil, and starch. It is a good complement to cereals (that are deficient in lysine) and legumes (that are deficient in methionine and cystine). In fact, quinoa is very close to the FAO standard for human nutrition requirement of protein. Quinoa seeds are traditionally toasted or ground into flour, although they may also be boiled and used like rice. Most varieties must be milled or washed well in cold water to remove bitter saponins from the seed coat. Quinoa leaves are also edible and nutritious. AZ 78; *EDN* 52-5.

Yard long Bean (*Vigna unguiculata* ssp *sesquipedalis*). As the name suggests, the pods on this bean plant are very, very long! You only need a few in order to make a meal. The pods are best eaten when they are young, before the seeds cause the pod to bulge. This species is much more tolerant of heat and humidity than the green bean, *Phaseolus spp. EDN* 60-5.

Uberlandia carrot (*Daucus carota*). Now farmers can save their own carrot seed, even in the tropics. Carrots are a popular crop in most countries, but some farmers cannot count on being able to purchase seed each year. Commercial varieties of carrot only set seed if the roots remain in the ground over a cold winter. The Uberlandia variety flowers soon after the roots mature, and then sets seed. A side benefit

is that the flowers provide food for tiny wasps that prey upon insect pests. Quality of the roots is not as good as commercial varieties, but we have simple instructions on how to develop your own variety over a few years. We also have a cross between a commercial carrot and Uberlandia that has higher quality and still sets seed in the tropics. You might want to try both. *AZ* 54 and *EDN* 74-7.

Underutilized species and varieties of fruit trees. An often overlooked way to bring a blessing to smallholder farmers is to introduce them to new fruit tree species or new varieties of species they already grow, and to teach how to propagate superior varieties by grafting. In most countries there are many fruit species and varieties that could quite possibly thrive and be popular, but neither farmers nor development workers have heard of them. Others know of these trees but do not know how to obtain and evaluate the trees. The special *EDN* 100 section of ECHO's website has links to information about many great fruit trees that you may not have considered. Those that grow well from seed and are in our seed bank are so indicated.

Plants Well-Adapted to Specific Difficult Conditions.

Disease-resistant FHIA bananas. Banana plants are susceptible to serious diseases such as Black Sigatoka and Panama disease. FHIA (Honduran Agricultural Research Foundation; www.honduras.com/fhia/banana.htm) bananas have been bred for disease-resistance. Some of these varieties are described in *EDN* 59-1. Goldfinger (FHIA-01), for instance, is described as a dessert (eaten fresh vs. cooked) variety able to support 100 lbs (45 kg) of fruit with no propping. Both FHIA-01 and FHIA-03 (a cooking banana) performed well in Honduras and continue to perform well at ECHO. The best source of plants that we know is a Florida-based company called Agristarts (website: www.agristarts.com; phone: 407-889-8055). On their website, click on the tab labeled 'Musa' for photos and information on varieties they carry. They sell plants in plug trays; at least ten plants can fit in a container about the size of a shoe box. They do ship internationally, charging $55.00/order for a phytosanitary certificate. After the plants bear fruit, it is likely that one or more of the varieties will be especially popular. If

there is great demand but you have only a few trees, what can you do? Fortunately two different techniques have been developed for rapid multiplication of bananas, one in the field and one using a banana corm. See *EDN* 59, 66, 75, and 99 (re *EDN* 75-6: note that Dr. Rowe, who had been supplying tiny, tissue cultured plantlets, is no longer living).

ECHO evaluated nine FHIA varieties and two commercial varieties in Haiti. Disease incidence with the two controls ('Gran Nain' and 'Williams') ranged from 56% to 61%, but was much less with the FHIA varieties, ranging from 11 to 32%.

Pigeon pea (*Cajanus cajan*). Seeds of this perennial legume can be harvested long after dry weather has killed most vegetables. Commercial varieties are selected for seeds that mature all at once and are easy to harvest, while dooryard varieties are selected to have blooms, green and mature pods at all times to provide a uniform supply of food. "Vegetable type" pigeon peas are especially selected for populations that prefer to eat plump green seeds rather than the more usual mature, dried seeds. Some varieties are dwarf in size and produce quickly, while others can reach 9 feet in height. Local farmers might like to see a trial where a few of each of several varieties were grown at one time. *AZ* 86; *AZ* 173; *EDN* 71-9.

Perennial lima (*Phaseolus lunatus*; 'Seven year' or 'Hopi' varieties). Danny Blank writes, "We first came across these beans when Lance Edwards from Zimbabwe reported how he would promote them among families with one or more members having HIV/AIDS. He encouraged planting several seven year lima seeds around homes, where they would grow up the sides of houses and even cover the roofs. Perennial lima varieties, depending on climate and conditions, can produce beans for many years. We grow them successfully as a food producing cover crop during our dry season at ECHO. However, long-term health and production appear better when growing on a trellis of some kind. They are characterized by vigorous growth and wide adaptability with good tolerance to some common insect pests like leafhoppers. We recently heard of some perennial lima types used as food producing ground covers in wet and humid climates. We acquired seed from Central America and will be experimenting with these. The two cultivars we currently offer are best suited for dry climates, but can persist through our intense rainy season, especially if growing on a trellis. It is one of the easier pest-tolerant beans to grow at the ECHO farm." *EDN* 81-8.

Queensland lettuce (*Lactuca sativa*) resists bolting in hot weather. Often lettuce could be a valuable cash crop near cities where there is a demand for western-style salads. But the tendency of lettuce to bolt (send up a seed stalk) in hot weather usually limits use where the weather is hot all year. The 'Queensland' variety is beautiful and remarkably resistant to bolting. We have had good reports from our network on this variety. Farm Manager Danny Blank says, "I don't think we have a lettuce that rivals this one in terms of heat tolerance and slowness to bolt." *AZ* 61.

Incredibly drought-resistant tepary beans (*Phaseolus acutifolius*). These beans are an important crop for American Indians in the arid southwest part of the USA. If seeds are planted at a time when the soil is moist, plants grow quickly and will produce well even if there is no rain after they bloom. Because tepary bean is adapted to very arid conditions only, it is not suited to climates with high humidity and frequent rains, where diseases harm or kill the vines. Drought-resistance is mentioned in *AZ* 89.

A high-yielding variety of sorghum (*Sorghum bicolor*) with resistance to striga. Striga, also known as witchweed, is a parasitic weed that infests cereal crops including sorghum. Crop damage occurs as striga plants penetrate the roots of host plants, diverting essential nutrients to the weed instead of to the crop. Striga thrives in areas of low soil fertility and plant diversity. By the time the flowers appear, damage to the crop has already occurred. Crop loss can be as high as 70%. *EDN* 59-2 contains more information about striga and highlights a striga-resistant variety of sorghum developed at Purdue University. Of the sorghum varieties that we have grown on our demonstration farm at ECHO, the striga-resistant varieties have consistently performed best, even though we do not have striga. We have seed available in trial-sized packets. If you have received seeds of striga-resistant sorghum from ECHO in the past, we would be interested in reports of its performance in the field and acceptance by local farmers.

Sorghum (*Sorghum bicolor*) If grain sorghum is an important crop where you work, there are some great options for doing variety trials on your project site or by farmers in their own fields, guaranteed to generate a lot of interest (see the story in *EDN* 95 of a sorghum variety trial ECHO planted to show farmers in Haiti). There are striking differences among sorghum varieties. Heights range from 3 to 9 feet (1 to 3 m). You may be able to harvest the short varieties before the taller ones even begin to bloom (there might even be enough time for two crops). Birds can easily eat grains from the open heads, but there are varieties with some resistance. However, the nutritional value of most bird-resistant varieties is inferior. Varieties can differ greatly in the shape of the head and color of the grain. Giza 114 produces grain but the stalks are of almost equal value in Egypt for cooking fuel. As mentioned above, special varieties are resistant to striga, a terrible parasitic weed in Africa. The best brooms are made from the long fibrous seed panicles of "broom corn," which is actually a sorghum.

Books

Jane Volker, ECHO's librarian, talked to many ECHO staff and put together a list of most-recommended books. The list is similar to one that she offers to visitors and conference delegates, and includes books that would be especially valuable for those trying to begin a library in an overseas development office. All of the books listed here are available from the ECHO bookstore (online at www.echobooks.org).

Amaranth to Zai Holes: Ideas for growing food under difficult conditions, by Laura S. Meitzner and Martin L. Price. This book is a compilation of material from *EDN* issues 1 through 51. Now, with the publication of issue 100, we are planning to write a sequel based on all that ECHO has written in 27 years.

Two Ears of Corn: A Guide to People-Centered Agricultural Improvement, by Roland Bunch. This book, available from ECHO's bookstore in English, French, Portuguese and Spanish, was published in 1982. It is a "must read" for those working to help smallholder farmers. If you are just getting started and have had minimal experience, you may find the book revolutionary. The rest will find it helpful, as well as a good introduction for those coming to work with you. The needs around you are too great to ignore just because you are not an "expert." But there is great wisdom in learning what you can before moving ahead.

Here are some selected chapter headings: The program goals; the program area; planning; start slowly, start small; limit the technology; choosing an appropriate technology; small-scale experimentation; teaching the technology; employees; supporting services; evaluation and phase-out; multiplying our efforts; building institutions; integrated programs. We especially appreciate the chapter on small-scale experimentation because this is at the heart of much that ECHO does. The author shows that it is possible to find new and better methods or resources with your own experiments and by involving farmers in experimentation.

Food from Dryland Gardens, by David A. Cleveland and Daniela Soleri; available on CD only, from ECHO's Global Bookstore. A review is in *EDN* 77-6.

Fruits of Warm Climates, by Julia F. Morton. See a review of the CD-ROM in *EDN* 70-7. The entire text of this book is online (www.hort.purdue.edu/newcrop/morton/index.html.

Growing Vegetables in Fiji, by Kirk Dahlgren. A concise guide to gardening in hot, humid climates.

The Miracle Tree; Moringa oleifera, Natural Nutrition for the Tropics, by Lowell J. Fuglie, NY: Church World Service, 1999. This book contains valuable information about moringa (uses, nutritional content, etc). It also adds an important human face by reporting results of a moringa project in Senegal, including interviews with people who have benefited from moringa. Some of the information in this book is summarized in *EDN* 64-6.

Plant Resources of Tropical Africa (16 volumes, full-text available on website www.prota.org), PROTA Foundation. *EDN* 93-6 mentioned this resource. Jane writes, "The online volumes of *Plant Resources of Tropical Africa* are the greatest bargain if there is a good internet connection because they are extremely comprehensive." They have a lot of plant information, though they are lacking color pictures.

Producing Food without Pesticides: Local solutions to crop pest control in West Africa, by Lowell J. Fuglie. Senegal: Church World Service, 1998. Reviewed in *EDN* 84-5.

The Seed Savers' Handbook, by Michel and Jude Fanton. Recommended by staff from ECHO's seed bank.

Traditional Foods: Processing for Profit, edited by Peter Fellows, London, UK: Intermediate Technology Publications, 1997. Reviewed in *EDN* 60-7.

Where There is No Doctor: a village health care handbook, by David Werner. In addition to medical information, this book contains some information about nutrition.

Humanity Development Library, v2.0, **one CD with 1200 books and magazines related to development, is available free to workers in developing countries.** This is an incredible resource. We counted 113 books from the USA Peace Corps, for example. Others who gave permission to include some of their publications include: ECHO, GTZ, NRI, BOSTID, FAO, Oxfam, Tool, WHO, United Nations, IIRR, UNESCO, IDRC and more. All seem to be complete, except that pictures have been left out in some cases.

ECHO has lost contact with the European organization that produced the CD, but we still have several in our bookstore. If you work with an organization that assists smallholder farmers in a Third World country, you may email ECHO@echonet.org and request a free copy (for as long as they last).

Magazines and Online Resources

LEISA **magazine for information about Sustainable Agriculture**. The acronym *LEISA* stands for Low External Input Sustainable Agriculture. Issues can be read online at *LEISA*'s website (www.leisa.info/). Articles in each issue are centered around a theme: for example, some recent issues cover topics such as ecological pest management; securing seed supply; and energy on the farm.

Spore is "an information magazine for agricultural and rural development in African, Caribbean and Pacific countries: trends and opinions, technical innovations, business, recent publications and useful contact sources." It is available in English, French and Portuguese. Issues can be read online, and paper copies are free to groups (not to individual farmers) in ACP (sub-Saharan, Caribbean and Pacific) countries that are involved in agriculture and rural development. Eligible countries are listed on *Spore*'s website (spore.cta.int). Others can subscribe to the magazine.

Footsteps **magazine for health and development workers.** This quarterly faith-based magazine shares practical ideas in a straightforward manner, at a grassroots level. According to the website, "Footsteps encourages a holistic approach to development and seeks to build up local capacity. Each issue concentrates on a different topic. Recent issues have included…literacy, theatre in development, financial management, pollution, facilitation skills, water and the impact of HIV on children. Over 60 issues have now been produced." The *Footsteps* website contains back copies of all issues, searchable by topic (tilz.tearfund.org/Publications/).

Footsteps is available for free in seven languages–English, French (*Pas á Pas*), Spanish (*Paso a Paso*), Portuguese (*Passo a Passo*), Chinese, Bangla and Hindi. Request *Footsteps* via e-mail at footsteps@tearfund.org. To request the print version, e-mail or write to "*Footsteps* magazine, Tearfund, 100 Church Road, Teddington, TW11 8QE, UK" with a postal address and language preference. Please also give brief details about your work.

Tearfund, the group that publishes *Footsteps*, allows articles and illustrations from the publication to be adapted for use in training materials that encourage health and development, so long as the materials are distributed free of charge and credit is given to *Footsteps*, Tearfund. Readers are also invited to contribute to *Footsteps* (views, articles, letters and photos) using the address above.

Training and Other Resources

Tillers International helps people around the world learn how to use animals to do work on the farm. They offer classes, workshops and internships on their farm in Michigan (USA). They develop and share designs for making animal powered equipment and other useful and marketable items. Classes currently on their website include topics like draft animal logging, ox driving, broom making, knife making, basic blacksmithing, draft horse training, building village roads and a great many more. Check them out at tillersinternational.org or email at tillers@tillersinternational.org.

Crop Protection and Seed Saving

Nematode management. Plant-parasitic nematodes are a problem for farmers throughout the tropics and subtropics. Root-knot nematodes cause the most damage at ECHO. Information about several methods of nematode management is in *EDN* 75-1. Also see *AZ* 201; *AZ* 102.

Seed inoculants to maximize the ability of leguminous plants to fix nitrogen. Leguminous (nitrogen-fixing) crops and trees are an excellent source of non-chemical nitrogen for agricultural systems. Examples include crops like beans, cowpeas, and pigeon pea, or trees such as acacia, leucaena, and sesbania. The biomass of many legumes can add over 100 lbs/acre (112 kg/ha) of nitrogen every year. Leguminous plants "fix" nitrogen (take nitrogen from the air and convert it to a form plants can use) with the help of special bacteria from the *Rhizobiacae* family that colonize and form nodules on plant roots.

If your legumes look chlorotic (yellowing of the older leaves, sometimes caused by a lack of nitrogen in the soil), it is possible they have not been effectively colonized by bacteria. Some legumes must be colonized by certain groups of rhizobia in order to effectively fix nitrogen, so it is important to find out which bacteria species is needed for a given legume. This is especially important if the legume you want to grow is not common or native to an area; the local rhizobia may not be as efficient as those present in soils where the plant came from. A fairly extensive list of inoculation groups appears in an old publication entitled "Legume Inoculation" (www.caf.wvu.edu/~forage/library/; scroll down to the section on "Legumes").

Look for more information in an upcoming *EDN* article. Inoculants for major leguminous crops are inexpensive and readily available in the US (e.g. www.agstore.net). The ECHO seed bank is looking for international sources of inoculants to recommend, and we welcome your suggestions.

Bean weevils controlled by tumbling the beans. *AZ* 270 featured an article summarizing a technique for controlling bruchid weevils in harvested beans. Researchers found that weevil larvae must brace themselves against a hard surface (side of a container or neighboring bean) in order to bore through the surface of a dried bean. They then determined that this activity could be disrupted by turning each sack of beans end-over-end two to three times per day until inspection revealed no remaining live adults. The tumbling action of turning over the sacks dislodged the weevil larvae before they could tunnel through the seed coat, forcing them to begin boring into a different bean. The next tumbling time forced the weevils to begin on a third bean, etc. Weevils die if they cannot get to the food source inside the bean in a little over one day, so the containers that were tumbled had 97 to 98% fewer weevil-infected beans than those in non-tumbled containers. This technique would likely be successful with other pests with similar biology.

Controlling seed storage conditions. In many cases, seeds of high-value crops must be stored for a period of time before planting. During that time, proper storage conditions are absolutely critical, as seed quality can deteriorate rapidly under high heat and humidity. Quality of stored seeds depends on length of time in storage, storage temperature, and moisture content. With the exception of "recalcitrant" seeds (e.g. some tropical fruits like mango, jackfruit, and avocado that only remain alive for a few weeks or months), seeds of most crops can be stored for several years if the sum of the storage temperature (in ºF) and the percent humidity is close to 100. If seeds are stored at 80°F, for instance, the ideal humidity in the room or container should be around 20%. How can either temperature or humidity be reduced with no electricity? One technique we have tested involves storing seeds and oven-dried rice in a sealed container such as PVC pipe, and then burying the container in the ground. The rice absorbs moisture, keeping the relative humidity at 20 to 40%. Burying the container stabilizes the temperature. *EDN* 86-1.

Saving your own vegetable seeds. Saving seeds of vegetable crops could be of great value where there is no regular supply of quality seed. An article in a July 2006 issue of *Avant Gardener* is summarized in *EDN* 94-1. It addresses seed production issues such as the maintenance of seed purity (making sure that varieties do not cross with each other) and genetic vigor. It also provides helpful hints for growing, collecting and saving various types of vegetable seed, such as the recommended distance between plants of the same variety; how various types of vegetables are pollinated; and the minimum number of plants of a particular vegetable that must be grown and harvested in order to maintain adequate genetic vigor. Those new to seed saving will probably want to start with a self-pollinating crop such as beans or tomatoes. Seed purity is easier to maintain with self- than with cross-pollinated crops, and one does not need to harvest seed from as many plants.

Neem leaf tea or neem seed oil to discourage insect feeding. A compound called azadirachtin, present in neem leaves and seeds, is known for its usefulness in controlling insect pests. Neem seeds contain greater amounts of azadirachtin than the leaves, but the trees do not produce seed year round. *EDN* 54-3 recorded observations by Cindy Fake in Mozambique who used the leaves to make an insecticidal tea. The tea was made by pounding 500 g of green neem leaves in a mortar and pestle, adding 10 liters of water, letting the mixture sit overnight, and then straining it through a cloth with a small amount of soap. The soap was used to help the resulting spray stick to the leaves. Backpack sprayers were used to apply the tea to one of four hectares of maize and cowpea. Red locusts attacked surrounding plots of non-treated maize and cowpea. They landed on the neem-treated crops but did not feed on them. See ECHO's "Neem" TN on making an even more potent insect spray from neem seed oil. *AZ* 200.

Tephrosia (*Tephrosia vogelii*), a valuable green manure with insecticidal properties. Beth Doerr, a current staff member at ECHO, found in Malawi that tephrosia produced abundant leaf matter that could be used as a green manure or insecticide. According to observations by Beth and an extensionist in Tanzania, tephrosia leaves were found to be effective in several applications: 1) combining a tephrosia leaf extract with soap mixture to control aphids on okra; 2) using dried leaves for insect control in stored grain; 3) controlling insect pests on animals (cattle, sheep, goats) and 4) applying a leaf extract/soap mixture to the walls of a room to repel mosquitoes. Caution: tephrosia leaves have been used to kill fish, but this is not recommended as there have been reports of ill effects on people eating poisoned fish. More information on this subject can be found in *AZ* 203 (insecticide, etc) and *EDN* 65-7 (fallow management).

"Short day" onions to produce bulbs in the tropics. In tropical and subtropical latitudes, only certain varieties of onions, called "short day" onions, will produce bulbs. If you buy "long day" onion seed that is bred for more northern climates, your onions will produce tasty green salad onions. They may thicken a little, but will not produce bulbs. There are good short day varieties available from many suppliers. Onion scientist Dr. Lesley Currah tells ECHO, "A well-organized seed catalog will not just say whether onions are "short" or "long" day but will list the ideal day lengths for each variety, e.g. 11 to 13 hours, 12 to 14 hours, etc. *AZ* 62.

Saving onion seed. This is difficult. Dr. Currah says that you need a variety that will easily bolt (send up a flower stalk) the second year. You do not want a variety that bolts the first year because that trait would wreak havoc in your harvest. Select bulbs from the best onions and store them until the next season. Timing then becomes important. If you plant too soon while daily temperatures are increasing, the onions may go into bulbing mode and split rather than flower. Wait to plant the bulbs until the average daily temperatures have started decreasing. The stalk is susceptible to many diseases, so unless it is very dry, you may need to spray a lot. Our full interview with Dr. Currah in *AZ* 62 is filled with practical suggestions about growing onions in the tropics.

Storage of bulb onions. Growing bulb onions can be profitable—if the farmer and/or the retailer can store them. Tom Post wrote to ECHO about how an innovative local farmer's success growing bulb onions turned into failure. The farmer found a way to produce nice bulbs in a region where few farmers could achieve this. But the next year he could hardly sell the onions because the storekeepers who bought his onions the year before had suffered huge losses during storage. Thus, it is important to realize that cultivars vary considerably in how well they store.

Cultivars suitable for storage should produce a number of outer dry scales or skins that form a vapor barrier around the

bulb, thereby minimizing moisture loss and the entry of fungi or bacteria. Locally adapted onion varieties, selected over many years within the tropics, will probably store better than the imported types, especially the "short-day" varieties from temperate climates.

Bulbs may not store well if you add too much nitrogen fertilizer and irrigation that promote excessive bulb growth. For storage, the optimum relative humidity range is from 65 to 75%. For the farmer or villager without refrigeration, temperatures ranging from 25 to 30°C (77 to 86°F) would be the best choice. *EDN* 59-4 has several more tips.

Using owls to control rats. It is estimated that each year, Malaysian oil palm growers and rice farmers spend millions of dollars controlling rats. Millions more dollars are lost due to the damage rats cause to crops. In the 1980s successful efforts were made by the Oil Palm Research Institute in Malaysia to increase the number of barn owls. All they needed to do was to provide the birds with artificial nesting sites. Inadequate nesting areas had discouraged owls from breeding despite the food surplus. The occupancy rate of nesting sites in one oil palm estate reached 80% during the breeding season. The Institute recommends placing one nest box every 10 ha.

An article in *Groundcover* (No. 24, 1996) concluded, "The Malaysian research has helped dispel the myth that barn owls hunt only in open areas. They found that the birds change their hunting mode to suit the vegetation. Instead of flying over the area scouting for prey, the owls perch on palm fronds and wait for rats to pass by. The researchers put up perching posts to encourage this." The owls eat almost nothing but rodents. A breeding pair of owls with offspring needs about 1200 rats per year. To encourage populations of owls and other natural predators (e. g. chameleons and snakes), islands of natural vegetation in fields should be preserved. ECHO has simple plans for a barn owl nesting box on our website. *EDN* 54.

For another idea for non-chemical rat control, including a helpful discussion of rodent breeding biology and its connection to the growth of a rice crop, see *EDN* 93-3.

Health-Related Topics

Artemisia for malaria treatment. Putting the treatment of malaria in the hands of the poor is a powerful way to combat this devastating and deadly disease. Danny Blank says, "I saw [this] firsthand in Mozambique, where artemisia plants were grown to provide the valuable tea for treating malaria." *EDN* 95 provides a very thorough review of this remarkable plant, providing the how-to's of getting started, obtaining seeds of the high-artemisinin cultivar, growing the plants, and making the medicinal teas.

Aflatoxin. Aflatoxin is a toxin produced by fungi from several species of the genus *Aspergillus*. Aflatoxin is a serious health risk, especially in countries that do not have the means to monitor and limit exposure. Human ingestion of aflatoxin can have both chronic long-term effects and acute short-term effects. Animals are also adversely affected by aflatoxins. Crops containing high levels of aflatoxin are often deemed unsuitable for export, especially to countries with ever-stricter allowable limits. See *EDN* 87-1 for information, including prevention, detection and minimization of aflatoxin.

Leaf Protein Concentrate (LPC) for treatment of severe malnutrition. How does one achieve a balanced diet with plenty of protein where animal protein sources or even peanut or other legume seeds are too expensive? Leaf protein concentrate that can be easily made from leaves of plants is an outstanding source of quality protein and vitamins. It can be made with very little cost, even from some plants whose leaves are not normally eaten by people. It is a fairly simple process. Harvest and wash fresh leaves, grind them to a pulp, press juice from the pulp, bring the juice to a near boil, separate out the curds which form in the heated juice, and press the liquid out of the curd. The solid portion of the mild-flavored curd is the leaf protein concentrate (with protein amounts in the dried form around 50% or higher), which can be added to traditional recipes fresh or preserved in various forms. Leaf for Life shares a lot of experience and technical details on the technique, choice of plants, recipes, etc on its website at www.leafforlife.org/. See also *EDN* 80 and *AZ* 264.

Moringa high density planting for leaf powder. Since Lowell Fuglie with Church World Service in Senegal began promoting moringa leaf powder in nutrition centers, its use has skyrocketed around the world. Moringa does very well in high density plantings (e.g. 30 cm between plants or even less), from which great quantities of leaf biomass can be continually harvested for fresh or drying purposes, both at home and on a commercial level. One of several ECHO TN's on moringa contains a great pictorial guide on the production of leaf powder.

Indoor air pollution. The majority of people in developing countries cook over open fires. The smoke that results can lead to severe health problems. For an overview of the dangers, as well as some potential ways to reduce smoke from cooking fires, see *EDN* 85-1. A special workshop on cook stove design principles will be offered the day following the ECHO Agriculture Conference in December 2008.