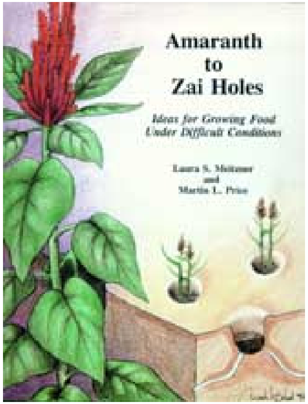
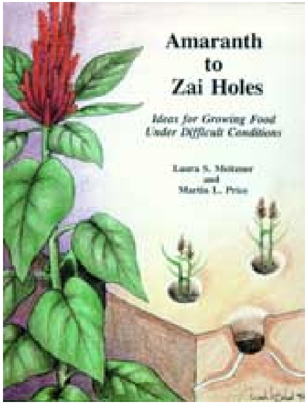

Amaranth
to
Zai Holes
Ideas for Growing Food
Under Difficult Conditions



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

Ideas for Growing Food Under Difficult Conditions
a compilation of the first 51 Echo Development notes bulletin

by Laura S. Meitzner and Martin L. Price

ECHO: North Fort Myers, Florida

To all who labor in so many fields.

...if you spend yourselves in behalf of the hungry and satisfy the needs of the oppressed, then your light will rise in the darkness, and your night will become like the noonday. The Lord will guide you always; he will satisfy your needs in a sun-scorched land and will strengthen your frame. You will be like a well- watered garden, like a spring whose waters never fail. Isaiah 58: 10-11 (NIV)

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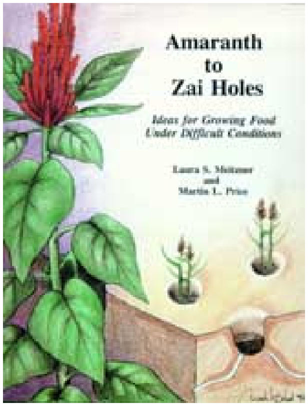
To purchase this book or for more information contact: ECHO 17430 Durrance Road North Fort Myers, FL 33917-2239 USA Telephone (941) 543-3246 Fax (941) 543-5317 Electronic mail ECHO@xc.org Web site http://www.xc.org/echo The price of this book is $29.95 plus postage; price may increase after 1998.

In addition to the book, the two latest ECHO development note bulletins 52 and 53, about 30 technical bulletins about tropical agriculture, and two basic documents; principles about agroforestry and good nutrition in the farm, are added at the end.



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

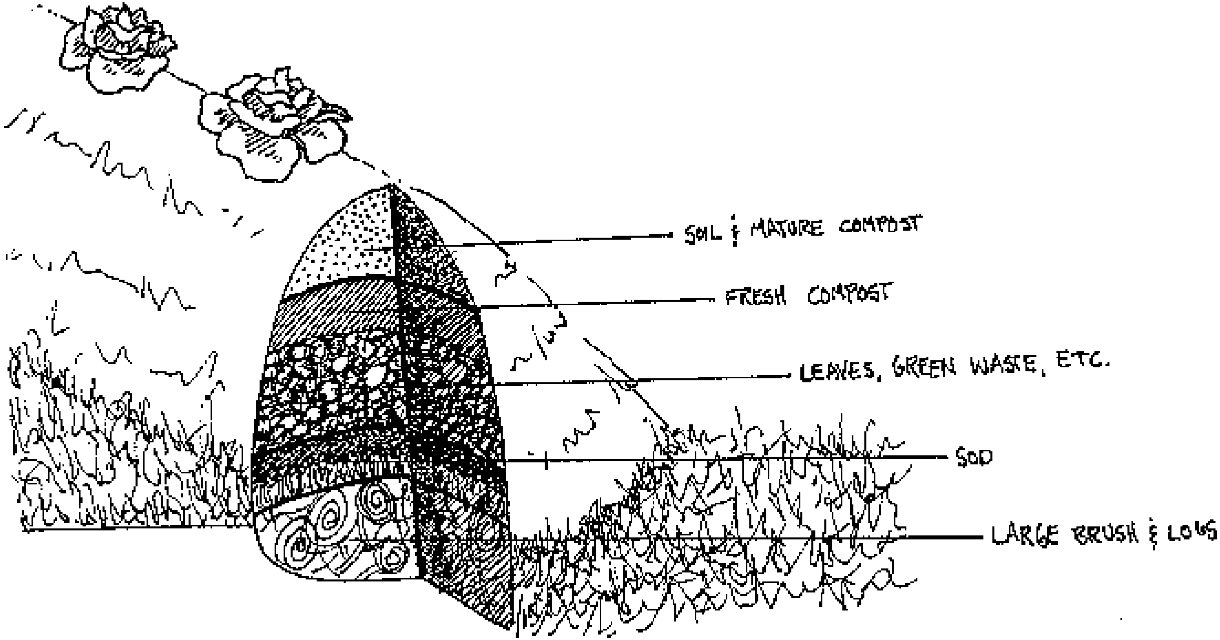
6: Soil health and plant nutrition

Productive, resistant plants start with healthy soil. Crops need not only adequate nutrients, but a favorable soil structure and environment for optimal growth. In the tropics, soil conditions vary widely, and many small farmers are forced to grow their crops in very poor soils which require special methods for food production. Green manures and cover crops, which afford some protection from weathering elements and may improve the soil, have proven themselves in the field for their contribution to soil health and conservation. This chapter also offers some ideas on planting materials and fertilizers for improved plant nutrition.

Soil types

COMPOSTING AND HILL CULTURE. There are three problems with the "proper" way to make fine compost. First, it is more work than most of us, including the subsistence farmer, have time to do. Secondly, most garden and farm residue is too big to decompose quickly unless a lot of work is done with a machete or shredder. Thirdly, humans like immediate gratification, something that only the most elegantly constructed compost piles can offer; the others take forever. We have been working on some methods to get around all of these problems, but now find they have already done that in Germany, with "hugelkultur" (hill culture). The following is taken from The Avant Gardener monthly newsletter.

"A hole 6 inches (15 cm) deep and 5 to 6 feet (1.7 m) wide is dug of any desired length and running north-south. In the bottom, twigs, branches and rotting logs are laid [I would put things like broccoli stems here too]. Then the sod removed when making the hole is laid face down on the wood layer. On top of this goes a deep layer of rotting leaves ...and green wastes.... Next comes a layer of fresh, nearly finished compost. Finally all this is topped with soil mixed with rich, mature compost. The completed mound can be as high as 30 inches (76 cm). Hugelkultur experts advise planting leaf and head vegetables such as lettuce, spinach, cabbage and cauliflower, plus tomatoes and cucumbers, the first year when there is considerable heating from the composting. The next year ... root crops can be added. The mound will last 7 years, its height gradually lessening and in the final year a perennial such as asparagus is planted."



composting and hill culture

[Subscriptions to The Avant Gardener for a year are $20 in USA; $24 overseas. Write to The Avant Gardener, Box 489, New York, NY 10028, USA. Though it is definitely oriented toward temperate horticulture, often ornamental, some of our tropical readers will find some articles helpful and interesting from time to time.]

The systems we are trying are quite similar. We make layers of whatever material we have available. By being able to plant immediately we not only get that "instant gratification" but also are able to make better use of scarce land by continuing to use the area for planting. Because it is in use, there is no hurry for the whole pile to decompose so there is no need for turning or chopping up the coarse material. You also have all the advantages of a raised bed. We are using fertilizer at least this first season because our top compost layer is thin and the decay inside may cause nutrient deficiencies at first. If we had manure tea we would water with it frequently. Instead we often use a soluble fertilizer, pouring it right over the leaves. Since we never seem to have enough compost, I will tear up some of these "hills" after a year or so rather than following the German scheme exactly.

Heat from decomposition may not be too serious a problem on a smaller scale. We have very nice carrots right now in a 12-inch (30 cm) tall 2 x 4 foot (60 x 120 cm) bottomless box that we placed on a cement slab and filled to the top with grass clippings and a bit of fertilizer. We then placed about 3 inches (7 cm) of potting mix on top and planted the seeds. By the time the roots reached the grass it had apparently cooled down.

Those of you with large amounts of rainfall are often discouraged to see the bit of fertilizer you were able to procure leached away by rains. Hill culture might help because the microorganisms that decay the organic matter in the interior of the hill use the same nutrients that plants use. As nutrients are leached into the pile they are "recycled" by these microorganisms and turned into compost.

THE HAITI MIX FOR STARTING SEEDLINGS. Many formulas for artificial potting soil give outstanding results when starting vegetable, flower or tree seedlings. The problem is that ingredients are expensive or not available in many locations. For example, at ECHO we start our seeds in a 1:1:1 mixture of peat moss, perlite and vermiculite. When Tom Post in Belize asked about using sugar cane for such a mix, I asked Jerry Larson with Double Harvest in Haiti about their experience. In the process of growing millions of tree seedlings, they have acquired a lot of experience with what they now call the "Haiti mix." His comments follow.

The basic ingredients are 5 parts sugarcane bagasse, 1 part rice hulls and 1 part sandy loam soil. Before they are mixed the sugarcane bagasse must be well decomposed. The best indicator is the color. Bagasse with a light yellow color has decomposed very little and must not be used. As decomposition proceeds the color goes through shades of red to dark brown or almost black. A dark cinnamon red color verging on brown indicates that the bagasse is acceptable, but the darker color is preferable. It is important that no undecomposed bagasse get into the mix.

The decomposed bagasse is finely shredded in a silage chopper and mixed with the other ingredients. A heating and sterilization process is initiated by adding urea to the mix at the rate of 1 pound per cubic meter of mix. [Ed: If you do not have urea, I would imagine other nitrogen sources could be used. Even ordinary fertilizer could probably be used, but it would make control of nutrients in the final mix less precise.] There is usually sufficient moisture in the bagasse to "kick off" the heating process. Within 2-3 days the temperature in the center should be about 145 F (62 C). Next the pile is turned inside out so that all parts will be heated equally. After just one more day the pile is flattened and packed down to stop the heating process. At this point the mix is in an unstable state and thorough packing is necessary if the heating process is to be controlled. Continued heating not only burns up nutrient value in the mix but, if allowed to continue unchecked, will chemically alter the mix and make it toxic to plants.

An effective method of packing is to drive over the flattened pile with a tractor. After that the pile can be left for several weeks or months with no damage. If the pile cannot be packed that tightly and if it is to be used within a short time span (several days), then it is permissible to have several men pack it by walking over it until it is as tightly packed as they can get it. Just before the mix is used, it is passed through a 3/8 inch hardware cloth to remove the larger particles. Five to six pounds of 12-35-24 fertilizer (depending on the stage of decomposition of the bagasse) is added per cubic meter along with 2 ounces of F-5-3 micronutrients. The mix should be used immediately because the fertilizer will otherwise cause it to heat up again and alter the nutrient balance. In this last stage, only as much mix as is going to be used each day should be prepared.

A PEAT SUBSTITUTE MADE FROM COCONUTS. [The following is based on an article by Alan Meerow in Country Folks Grower South, November 1993.] Coir is the fibrous part of the coconut husk. The long fibers are "extracted and sold to make brushes, automobile seats, mattress stuffing, drainage pipe filters, twine, etc. Traditionally the short fibers and dust left behind have accumulated as a waste product for which no industrial use had been discovered." Tests in Australia and Europe show that this product makes a remarkably adequate substitute for peat. "The Lignocell company in Sri Lanka (where over 2.5 billion coconuts are processed each year) has become the leading processor [of coir]."

Coir has a high lignin cellulose content, which keeps the piles that traditionally accumulate around processing plants from breaking down. The same property inhibits breakdown of coir pith when used as a growing medium.

The pith is very similar to peat in appearance. It is light to dark brown, with 0.2-2.0 mm particle size. "Unlike sphagnum peat, there are no sticks or other extraneous matter." A study in Australia found "superior structural stability, water absorption ability and cation exchange capacity compared to sphagnum peat." There are reports that coir from sources other than Sri Lanka have contained chlorides at levels toxic to many plants. Perhaps this is a result of the processing method. In any event, watch out for that if you begin using the pith.

"Lignocell processes the pith into highly compressed bricks roughly 8x4x2 inches (20x10x5 cm), each weighing 1.5 pounds (0.7 kg). They are exported for the retail market in 12-brick packages. The 12 bricks fluff out when re-wet into 4 cubic feet (0.1 m3) of ready-to-use material. Each brick absorbs about 2 gallons (7.6 liters) of water. I have been impressed by the ease with which coir pith re-wets after it has been thoroughly dehydrated."

The February 1996 HortIdeas cites research which cautions that coir can contain high levels of chlorine, which could affect seed germination. Leaching reduces chlorine levels quickly, and it is best to use coir that has been aged for at least one year.

[Ed: When I (LSM) was an intern at the Royal Botanic Gardens, Kew, we used coir rather than peat because of the adverse environmental impact on British peat bogs. Most of the horticultural staff preferred it to peat anyway. It worked well with nearly all plants, though they said it was not sufficiently acidic for the carnivorous plants. The coir surface can appear dry even when saturated below, so be careful to avoid overwatering.]

REMOVING SALTS FROM CONTAINER-GROWN PLANTS. I [MLP] vividly remember as a toddler watching my father boil down a can of saline water to show all the salt that was left behind. I think of that when week after week I water a potted plant during a long dry season or in a greenhouse where it never receives rain. As the water evaporates or is taken up by the plants, more and more salt builds up. Sometimes you can even see a white crust appear on top.

David Silber writes in the June 1992 issue of The Fruit Gardener that one way to correct this problem is to "semi- annually leach the soil with tap water (rainwater is better) that has been acidified to a pH of 4.0. I use a commercial grower's acid blend containing nitric and phosphoric acid. But you can also use vinegar as an acidifier: 2 tablespoons per gallon of water will yield the desired pH. The solution should be flushed through the growing container three times. In my experience the leaching water went in at a pH of 4 and came out at 6.5. This effectively removes lime and bicarbonates as well as sodium. I've used this on miracle fruit, coffee, pitomba, jaboticaba and lychee. The plants responded within two weeks with a new flush of normal leaves."

ECHO used this technique in the greenhouse where we grow rain forest plants. Plants were not thriving and leaf margins were turning brown on some species. They seemed generally healthier after the treatment.

The Fruit Gardener is published six times yearly by the California Rare

Fruit Growers chapters. Membership/subscriptions: $16 in USA; $25 Canada/Mexico; $30 foreign surface mail; $40 foreign airmail. Write: California Rare Fruit Growers, The Fullerton Arboretum, California State University at Fullerton, Fullerton, CA 92634 USA.

SALINE AGRICULTURE: SALT-TOLERANT PLANTS FOR DEVELOPING COUNTRIES is a 143-page book published by the National Academy of Sciences (1990). Like the other NAS books of this nature, it is a very readable overview of lesser-known resources for a difficult situation. Salt-tolerant crops (halophytes) might utilize land and water that are unsuitable for salt-sensitive plants. Looked at from a different angle, farmers whose poverty limits them to their present location where soils or water are salty might eke out a better living.

There are limitations, in part because relatively little agricultural research has been done with these crops. Salt- tolerant plants usually have poor agronomic qualities (e.g. there may be wide variations in germination and maturation times). Seeds of grasses and grains tend to shatter and fall to the ground. The foliage may not be suitable for fodder because of its high salt content. Nutritional (or anti-nutritional) characteristics have, in many cases, never been studied in the laboratory.

Sections are devoted to food, fuel, forages, and fibers.
FOOD: grains and oilseeds, tubers and foliage, leaf protein, fruits, traditional crops.
FUEL: fuelwood trees and shrubs, liquid fuels, gaseous fuels.
FODDER: grasses, shrubs, trees.
FIBER ET. AL.: essential oils, gums, oils and resins, pulp and fiber, bioactive derivatives, landscape plants.

Some of the plants we have talked about in EDN are discussed as having some degree of salt tolerance. The leucaena tree, Leucaena leucocephala, has been grown on coastal sandy soil in Pakistan through irrigation with saline water. Trees even survived when 20% seawater was used in the irrigation water, although yields were reduced by 50%. [See below for more information.] Jojoba (Simmondsia chinensis) is relatively salt tolerant, growing near the Dead Sea with brackish water irrigation in Israel. Quinoa (Chenopodium quinoa) germinated in a mixture of 1/3 sea water and 2/3 fresh water, though it would not continue to grow at that salinity. In the salt flats of southern Bolivia, quinoa is one of the few crop plants grown. In this arid region (230 mm/9 inches) rainfall, quinoa is planted in holes about 40 cm (16 inches) deep where the soil is damp. As the plant grows, soil is filled in around it. With wide stretches of salt beds nearby, the environment is certainly saline, but no measurements have been reported. [The book does not say whether they are using specially selected strains of quinoa.] Neem (Azadirachta indica) seedlings have been grown successfully in Pakistan on sandy soil using irrigation water with approximately 10,000 ppm salt. [Pure sea water is 35,000 ppm.] A neem plantation has been established near Mecca in Saudi Arabia to provide shade for Muslim pilgrims. Water with approximately 2500 ppm salt was used for irrigation.

Only two conventional crops have halophytic ancestors: beets and date palms. Both can be irrigated with brackish water without serious loss of yield. Asparagus is remarkably tolerant of salt. In Tunisia, where irrigation water contains 6,500 ppm salt, asparagus yields are about the same as in areas irrigated with fresh water. [ECHO staff Cory Thede comments that he remembers reading somewhere about applying salt for weed control in asparagus.] Barley is the most salt-tolerant cereal grain. At the University of Arizona, a special strain of barley yielded 4,000 kg per hectare when irrigated with groundwater with half the salinity of seawater. Selected strains were grown at the University of California on sand dunes with the following yields in kg/ha and salinities: 3,102 with fresh water; 2,390 for 1/3 sea water; 458 for 100% seawater. (Unfortunately the book says very little about vegetables. For some help on that subject, see "Helpful Facts About Salinity" below.)

Anyone working with salinity problems will surely want this book. If you are working with a governmental or non-profit organization, you may write the NAS on official letterhead, explain your work in no more than one paragraph, and ask if they might send you a free copy. The price in the US is $15. The address is Board of Science and Technology for International Development, Publications and Information Services (HA-476E), Office of International Affairs, National Research Council, 2101 Constitution Avenue, Washington, D.C. 20418, USA.

SALT TOLERANCE IN LEUCAENA? Dr. James Brewbaker at the University of Hawaii commented on the note above that leucaena has salt tolerance. "Leucaena's salt tolerance is effective only along shore lines where calcium levels are high. As with many other plant species, the tolerance of 'salt' is a complex subject, for salt can represent a great assortment of chemicals. Generally, the major difference is seen when comparing coastal salinity (highly calcareous) with inland evaporative salinity (e.g.

Salt Lake), which is usually not calcareous. Leucaena tolerates the former, not the latter."

Calcareous refers to soils with high calcium content, primarily coral-derived soils with accompanying high pH. Arid regions naturally have areas of high salinity due to evaporation and salt accumulation; such soils are often lower in calcium, higher in sodium, and thus more toxic to plants.

A few nitrogen-fixing trees do handle the salty non-calcareous soils. The best work with these is at CAZRI (Central Arid Zone Research Institute of India) in Jodhpur, India. (Please send us their complete address and more information about their work if you know it. Thanks!)

SOME HELPFUL FACTS ABOUT SALINITY. I pulled the following facts from Knott's Handbook for Vegetable Growers. On units of measurement: The following gives a helpful perspective when reading salinity literature that talks about ppm and millimohs per cm (sometimes written mmho/cm). 1 ppm (part per million) = 1 gram in 1,000 liters of water; ppm x 1,000 = 1%; 1,000 micromhos per cm (a unit of measure for electrical conductivity) = approximately 700 ppm; 1,000 micromohs per cm means that one ton of salt would be in the water that would cover one acre of land to a depth of 1 foot.

The handbook lists several vegetables and the mmho/cm in the soil that reduce yields by 25%. Beet (10), spinach (7), tomato and broccoli (6), cabbage, cucumber, muskmelon, potato, corn and sweet potato (4), lettuce, pepper, radish, onion and carrot (3), bean (2). So beets would be the best vegetable for saline soils, beans the worst.

Some general rules listed for likely crop response to salinity follow. 0-2 mmho/cm, mostly negligible; 2-4, yields of very sensitive crops may be restricted; 4-8, yields of many crops restricted; 8-16, only tolerant crops yield satisfactorily; above 16 only a few very tolerant crops yield satisfactorily.

PLANTING IN FRESH VOLCANIC ASH. Two members of our network in the Philippines asked what we could find out about this subject. Planting season is now near for farmers near Mt. Pinatubo. We called Dr. Allen Busacca at Washington State University about gardening in volcanic ash and what impact layers of ash will have on agricultural soils.

"Most of our experience has been with revegetation of natural areas (Mt.

St. Helens) rather than agricultural lands. While we generally think of volcanic soils as rich agriculturally, that is only after thousands of years of weathering. It has been my experience that ash is relatively neutral. Initially it is silica-rich, like crushed glass. In the case of the Mt. St. Helens volcano it was not very toxic. It is probably best to incorporate it up to maybe 6 inches (not an easy thing to do without equipment)."

"Not all volcanic ash is created equal. The best way to deal with a larger quantity depends upon whether it is light and fluffy or a fine, coarse pumice."

He referred us to Dr. Jeff Smith who was involved in some agricultural studies for the USDA. Dr. Smith said that there has been surprisingly little study of agriculture in fresh volcanic ash. "It will probably be a bit on the alkaline side and almost certainly will contain a lot of salts. So the first year only the most salt tolerant vegetables and grains should be grown. He is pretty sure that if they plant salt sensitive vegetables directly into the ash they will not thrive. On the other hand, there are volcanos where the ash was more like glass. Incorporating into the soil seems to help a lot."

There are no extension bulletins on the subject that he knows about. This would be a good research topic for one of our readers in the scientific community. If anyone has ever seen an extension bulletin or especially helpful research paper, or if you have had personal experience, we would like to hear from you.

ECHO's network shared quite a few helpful experiences. Ken Turner with Mercy Corps sent an interesting letter and pictures. "I guess I'm your reporter on the spot. Our community and my home (until the eruption) is 15 km from Mt. Pinatubo. We evacuated June 7, two days before the first major eruption. One of our staff returned a few weeks later. It looked pretty dismal.

"Now it is a different story. Some pretty amazing harvests have drawn a lot of attention. Banana planted a few weeks before the eruption produced a good crop. Most amazing was the watermelon harvest-more than twice the yields of past years, melons (sugar baby variety) twice the size on the average and still sweet, and vines more than twice the usual length.

"The ash is now about 8 inches (20 cm) deep. The soil has remained moist (and I suspect cool) under the sand, even after 3 months of dry weather. I did not check the pH, but 30 km from the mountain the pH is about neutral. It appears that sweet potato is thriving in rice fields 30 km from the volcano.

"The crops and generally lush growth is encouraging farmers to return, even though the road is likely to become impassible early in the rainy season. "

Victoria Coronel with IRRI sent very specific and helpful recommendations. Highlights are summarized. The eruption of Mt. Pinatubo brought havoc to more than 38,000 ha of farmland. Even though the Philippines has several active volcanos, they could find no published reports of studies on revegetation.

Some findings from the Mt. St. Helens volcano in the United States are relevant. (1) Ash has a lower permeability than soil. This means that flood water will remain longer on the surfaces of the ash-covered soils. (2) The ash layer acts as a surface mulch both reflecting solar radiation (increasing photosynthesis) and impeding water flow and evaporation from the soil to the atmosphere. An estimated 40-60% of the light is reflected. Peak daytime soil temperatures beneath 2-3 cm of ash were 6-10 C lower than adjacent sites where ash had been incorporated into the soil. (3) The abrasive effect of ash particles is harmful to insects. Unfortunately beneficial insects were the most affected.

Studies from Mt. Galunggung in Indonesia provided the following insights. (1) Crop yields were still high in areas with up to 20 cm of volcanic materials. Productivity declined with greater amounts. (2) Yields of rice and other food crops were high when the ratio of volcanic materials to soil were as high as 5:5 and 7:3. If there is less than 20 cm of ash, plowing into the soil seems the easiest solution. If deposits are deeper, adding organic matter may be needed (20 t/ha manure or other organic materials). Dumping organic waste from Manila has been suggested, but transportation is a problem. Green manure crops may be the answer.

The following cropping pattern was suggested if volcanic materials are less than 20 cm and the irrigation system is intact. After plowing 30 cm deep (a 7:3 ratio of volcanic materials to soil), plant rice-rice-corn/ soybean or rice- rice-leaf onion. For 20-30 cm thick deposits, plow the volcanic material when dry, incorporating any organic material that is available. Food crops can be planted in the early rainy season. Rice and corn are not generally recommended. If volcanic materials exceed 50 cm, pineapple would be suitable since it thrives well in sandy soil with pH range of 4.5-7.l5 and requires minimum care and inputs. Hybrid coconuts can also be planted. Fruits like guavas, nangka [jackfruit], papaya and banana grew well, even better than before the eruption of Mt. Galunggung.

Preliminary tests show some rice varieties do better than others. The top 3 were all varieties grown in acidic areas of Indonesia. In one area, corn exhibited early leaf yellowing (corn requires a lot of nitrogen). Sweet potato gave the best growth, followed by kangkong and cassava. Green manures also gave initial excellent growth. A second eruption destroyed the experiment.

IRRI recommends that the above fruit trees be planted as quickly as possible for the longer term; that sweet potato, cassava, kangkong and green manures be planted for the intermediate term; that livestock that eat roots (e.g. swine) be associated with sweet potato and cassava growing; that aerial seeding of green manures, including ipil-ipil [leucaena], be considered.

Scientists desiring to see the entire report, "Mt. Pinatubo-Controlled Revegetation" by B. S. Vergara and V. Coronel can write to Dr. Coronel at IRRI, P. O. Box 933, 1099 Manila, PHILIPPINES. Workers outside of Asia can write to ECHO.

RESOURCES ON SOIL HEALTH. We asked Marianne Sarrantonio, author of the handbook Methodologies for Screening Soil-Improving Legumes and professor of agroecology at Slippery Rock University, Pennsylvania, USA, to recommend a few hands-on resources from the emerging science of soil health (or soil quality). (This book is available in English and Spanish from Rodale Institute, 611 Siegfriedale Rd., Kutztown, PA 19530, USA.) "Local extension groups in your area are a good place to check for hands-on manuals on composting and green manures. I think that Grace Gershuny's books The Soul of the Soil and Start with the Soil are excellent for those without science training." Contact John Doran (ARS-Nebraska, USA, 402/472-1510) after mid-1996 about his how-to manual for measuring and monitoring soil health.

Green manures and cover crops

THE INTERNATIONAL COVER CROP CLEARINGHOUSE (CIDICCO is the

Spanish acronym, for Centro Internacional de Informacin sobre Cultivos de Cobertura) was established in 1990 to provide an exchange of ideas, information and experiences among groups and individuals interested in promoting cover crops among village farmers. They collect and distribute information on leguminous cover crops and green manures from both scientists and practitioners in the field, document field experiences with cover crops, publish technical reports and the newsletter "Cover Crop News," and coordinate networking among members. (ECHO is normally able to provide packets of seed for any of the plants they mention.)

The publications are often field experience-based descriptions of cover cropping systems (highlighting velvet bean, lablab, jack bean, and other legumes) and management practices. Clear information regarding cultivation is given to help you adapt the system in your area. The publications give a very balanced perspective on the use of cover crops, defining where they can be useful as well as mentioning limitations for the farmer. Most are available in Spanish and English and cost $1.50-2.50; write CIDICCO for a publications list.

The director of the program is Milton Flores. Milton would love to hear from you whether you are experienced with green manures or just beginning to try them. You do not need to be an "expert." If there is something going on in your community which he might like to see, be sure to describe it. To receive their newsletter write: Milton Flores, CIDICCO, Apdo. 4443, Tegucigalpa, MDC, HONDURAS; phone (504) 32-7471, 32-9870, 39-5851; fax (504) 39-9896; e-mail cidicco@nicarao.apc.org.

ENTHUSIASM FOR COVER CROPS is contagious. Roland Bunch wrote, "Our extensionists in Honduras who have worked in some of the most successful programs in Central America told me several times that they have never before seen a technology develop so much enthusiasm and take off with so little program effort. They have done virtually no promotional work on it, yet it is taking off like wildfire. The program is harvesting seed by the 100 pound bag and cannot meet even a fraction of the demand." He mentioned that one farmer told him he is saving $100 per year in coffee purchases by using the roasted beans of one ground cover, velvet bean, as a coffee substitute. Doug and Ruth Welch mentioned that it is used in this way in Zaire also.

GREEN MANURE CROPS OFFER TREMENDOUS ADVANTAGES TO THE SMALL FARM IN THE THIRD WORLD (1985). By Roland Bunch, at the time with World Neighbors, Honduras. (Now a consultant with COSECHA, Apdo. 3586, Tegucigalpa, HONDURAS, Central America.)

Green manure crops are crops which are grown to be turned under to increase soil fertility. Leguminous green manure crops, i.e. those which can make nitrogen fertilizers from atmospheric nitrogen, can offer small-scale third world farmers a tremendous number of advantages:

1) They provide large quantities of nitrogen for the soil.

2) They add many tons of organic matter to the soil, thereby improving topsoil depth, water-holding capacity, nutrient content, friability, and texture of the soil.

3) Since the green manure crop grows in place, it presents no transportation problems, in contrast to either compost or chemical fertilizers.

4) Green manure crops require absolutely no capital outlay after the initial purchase of seed. They require no chemical inputs, so dependency on outside sources of fertilizer, nutrients, and pesticides is reduced.

5) Green manure crops can shade the soil up to eleven months out of the year, a factor extremely important in tropical climates for preservation of soil moisture and organic matter.

6) The cover they provide for the soil protects the soil from wind or water erosion.

7) Green manure crops provide generous amounts of high protein fodder for animals, which can be especially valuable if it is available during the last months of the dry season (since fodder at this time of year is the limiting factor in traditional animal-raising in much of the third world).

8) Some green manure crops provide human food, including various kinds of edible beans, peas, and pods.

9) Green manure crops can provide a cash income, by selling firewood, food or feed (and maybe seed).

10) They often provide an incentive for people to abandon harmful traditional practices, such as burning crop residues or letting animals loose in the dry season to devour everything in sight.

11) Some green manures can control weeds when intercropped with grains, eliminating costly weeding operations.

Something like 30% of all the increases in harvests achieved by small farmers in the third world during the last three decades has been achieved through the use of chemical fertilizers. Should petroleum prices shoot up once again, as could easily happen sometime in the next decade, prices of chemical fertilizers could easily become too expensive to be economically feasible for use with traditional basic grains. Almost overnight, third world basic grain production could plummet, causing famines the extent of which would make the present situation in Africa seem mild by comparison. Widespread use of green manure crops could avert much of this impact.

Comparison with Compost. As composting is a technology that is often recommended for third world development programs, it might be useful to compare composting with the use of green manure crops.

1) Compost merely decomposes the organic matter one already has, whereas a green manure crop can often add over 40 tons of additional organic matter per hectare. Inasmuch as organic matter is often in short

supply on villagers' farms (or is already being recycled), this is an important consideration.

2) At best, compost will return to one's field about 98% of the nitrogen one started out with. A green manure crop, however, will add considerable quantities of new nitrogen to the system.

3) A compost heap takes a tremendous amount of work, as anyone who has made one can attest. Though compost will often pay in a vegetable garden, it is not economical when used on basic grain crops such as corn or millet. On the other hand, although a green manure crop takes a bit of labor to plant (using a dibble stick) and a fair amount of labor to incorporate, it takes much less labor then a compost heap. And in some cases where the green manure crop is intercropped among traditional crops (such as corn, sorghum, or millet), it covers the ground so well that one or even two weeding operations can be eliminated, thereby actually bringing a net savings in labor.

4) Compost heaps require water, so they are made near a water supply but at a distance from where they will be applied. Green manure crops take advantage of available rain water, and are planted where they will

be used.

5) Compost cannot be used as a food source, either for animals or humans.

A Few Ideas About What to Look For. The major problem with green manure use around the third world is that village farmers cannot afford to give up land in order to grow "just" a soil amend- ment. Or when they have the land, they cannot spare the labor. However, there are three ways in which these objections can be overcome. In many situations only one of these will be appropriate, in others two. Only rarely is none of them appropriate.

1) Green manure crops can often be planted among traditional row crops, especially corn, sorghum, and millet, without decreasing the production of the main crop at all the first year, and usually with major increases in the major crop in succeeding years. The major instance in which this is not possible is when people are already intercropping two or three other crops with their major grain.

2) Green manure crops can often be intercropped with basic grains toward the middle or end of the growing season, with the idea that their

major growth would occur during the dry season, thereby using land that would not ordinarily be under cultivation.

3) Where multiple-year fallows and/or shifting agriculture is used, green manures can be planted on land the first year it is to go fallow, cutting the fallow period to one year instead of 3-15 years.

What characteristics should we look for, then, in a legume that will be useful under these circumstances?

1) It must be a non-woody annual with vigorous growth.

2) It should grow well in the poorest of soils in the area, without needing any kind of fertilizer.

3) One must be able to plant it in local fields with no special soil preparation, and either with a dibble stick or, preferably, by broadcasting the seed.

4) The plant must have few natural enemies so that it will grow vigorously without pesticides or major labor requirements.

5) The legume should either be very shade-resistant (for intercropping) or drought-resistant (for growing into or through the dry season).

6) If possible, it should first cover the ground well, then climb any stalks that remain in the field.

7) If possible, the green manure crop should be edible by animals and/or humans.

Some Already Known Possibilities. For details on species used as green manures, see the following article.

Miscellaneous Observations.

1) What can be done in areas where animals are let loose during the dry season while the green manure crop is still growing? One approach is to first show people the results of the green manure plant on an enclosed piece of land. Next get a good number of people to try it out, perhaps timing the planting to get a good start before the animals are let loose. Those who experiment first can often be motivated to spread the word to others with the idea that the destruction for each person will be less if more people plant it. Eventually, if enough people plant it, community

pressure will make everyone keep his animals locked up (except in cases where the person with all the animals is a large landowner).

2) On very steep hillsides, something must be done to keep the organic matter from washing away. Piling crop residues along rough contour lines can help, as can contour ditches. Another possibility is incorporating the green manure immediately after cutting it, but this is hard work before the rains come (if the soil is a heavy one), and once the rains have come, people generally do not have extra time.

3) On flatter land, the green manure should usually be cut and allowed to dry for a couple of weeks before incorporating it (if during the dry season). The labor saved in incorporating it will be worth more to the farmer than the small amount of fertility lost. In one case farmers cut holes in the Canavalia (jack bean) cover to plant corn when the rains came, cut down the Canavalia entirely about two weeks later and replanted the Canavalia. Then, two weeks later, they incorporated the dead Canavalia vegetation. In this manner, they avoided both weeding operations in their cornfields!

4) Where weather is unreliable, a combination of similar plants, one of

which is more drought-resistant (e.g. jackbean and velvetbean) reduces risk of total loss, yet assures a vigorous crop if rains are plentiful.

5) In West Africa, we are trying a system of planting a perennial every sixth row (pigeon pea), and then gathering the corn or millet residues under the pigeon pea plants at the end of the year, to be distributed six months or so later when well-mixed with pigeon pea leaves, which have a better carbon-to-nitrogen ratio. The presence of the pigeon pea trees (already known as a cash crop) will also prevent burning of residues.

6) On South and Southeast Asian hillside areas, Leucaena leucocephala is planted as a contour barrier and constantly pruned, thereby providing erosion protection, some green manure, and firewood (see the booklet produced by World Neighbors called "Leucaena-based Farming"). This produces less green manure than other systems, but can be used where green manure cannot be intercropped among traditional crops.

7) We certainly would welcome any experience you have in this subject. Much more information and experi- mentation must be done. We are still learning about this, but the positive response from hundreds of villagers and dozens of other programs has made us decide to share what little we

know as soon as possible so we can all work together to learn more about it. I would think that, right now, the most important subjects we need to learn more about are:

a) What legumes will work above 1,800 m?

b) What additional plants will work at any elevation?

c) Do adaptive research to see which of these technologies will work outside the Southern Mexico/Central American habitat that this information comes from.

d) Which legumes can be broadcast rather than planted with a dibble stick?

e) Which of these green manure crops provide the best yield increases with which basic grain crops?

f) What green manure crops would be best under high rainfall conditions?

WHAT WE HAVE LEARNED TO DATE ABOUT GREEN MANURE CROPS FOR SMALL FARMERS (1987, contributed by Roland Bunch). [CIDICCO (see above) now offers the recent technical report "The Use of Green Manures by Villager Farmers" (1995, 7 pp., by Roland Bunch) in English or Spanish for US$3 including postage. Those considering implementing and promoting a green manure (GM) system would benefit from reading this article. It outlines the following topics: advantages and disadvantages of GMs for villager farmers, achieving the adoption of GMs, research priorities, and promising species for low, intermediate, and high elevations.] Here we present a few other insights from Roland Bunch regarding GM systems and the species often incorporated into the system.

In spite of the advantages of green manures, their use seldom became common among farmers in the third world. They cannot afford to give up scarce cropland just to grow a soil amendment. If they do have the land, they cannot afford the labor. Nor are they generally willing to spend money to improve crops grown for subsistence, because they earn no money from them with which to replace what they have spent.

World Neighbors/Central America has found a number of ways to overcome most of these problems to the extent that farmers have accepted green manures faster than any other agricultural technology with which we've worked through the years. One program sold 65 pounds of seed last year to local farmers and 1500 pounds this year in the same area with minimal promotion.

To summarize some ways to produce green manure without reducing at all the land used for other crops:

(1) Plant among traditional row crops.

(2) Intercrop near harvest of the first crop timed so green manure will grow primarily during the dry season.

(3) Where shifting agriculture is practiced, plant during the first fallow year to shorten the fallow period.

(4) Plant under fruit or coffee trees.

(5) Plant leguminous trees along soil conservation ditches on hillsides.

(6) Alley cropping. In Central America our work has used the first four possibilities. We have had the most success with jack bean and velvet bean.

Jack bean (Canavalia ensiformis) is an incredibly drought-resistant, shade-tolerant, hardy legume that grows well in extremely poor, droughty soils (and apparently less well in fairly fertile soils). There are two kinds of jack bean, one that climbs and thoroughly covers the soil, and another that has a bushy growth habit and does not climb at all. It begins flowering after 4-5 months, then produces seed pods continuously for at least the next year. It will grow through some 5-6 months of dry season if above about 600 meters and can serve to shade the soil during this time to prevent loss of organic matter. Under 500 meters it will often stop growing after about 3 months without rain and may even drop its leaves if soils are thin and temperatures exceptionally high. The stem will become somewhat woody, but only if left for seed and under fairly warm conditions.

Jack beans grow vigorously at sea level, and can be used as a green manure crop up to about 1600-1800 meters. It does not thrive in soils with excess water. They do very well in corn fields, but are preferred over velvet beans only when it is too dry for velvet beans to thrive. This tends to be the case where corn has been replaced with sorghum or millet due to insufficient rainfall. I have seen it grow vigorously on soil so badly eroded and depleted that no weeds would grow there at all.

The jack bean will be eaten by grazing animals, but is liked less than other green manures. Hence jack beans are preferable where animal damage is feared. Non-climbing varieties are proving to be very good for weed control and nitrogen fixation under fruit trees. It has virtually no natural pests or diseases. Its leaves are sprinkled on leaf-cutter ant hills to eliminate them. [Ed: I am told that ants carry leaves into the mounds as food for the fungi upon which they live. Jack bean leaves reportedly kill the fungi. Dr. Warwick Kerr in Brazil writes that planting sesame near the mounds has a similar effect].

Jack bean should be planted in soil that has been cultivated within 3 years and weeded very recently (although at elevations below 500 meters or in sandier soils, cultivation may not be needed). We use 4-5 seeds per square meter in order to control weed growth. (In corn fields an important advantage of this and the velvet bean is that use of these plants may entirely eliminate at least the second weeding). Jack bean has even been planted in fields already intercropped with both corn and beans in Haiti (Bois de Laurence) without much adverse effect on even the beans. If planted in a corn or sorghum field, it should be seeded within 15-30 days of the primary crop, depending on climate, speed of growth of the other crop, etc. It can be planted with a dibble-stick (at 2 seeds/m2) or broadcast (at 4 seeds/m2), though if broadcast it will take another 2 weeks or so to germinate unless soaked in water overnight before planting.

People can eat immature pods like green beans when they are about 7-8 inches long. In Southeast Asia the mature beans are eaten, but we have not been able to find out how. Cooking must be sufficient to eliminate certain substances in the mature bean that inhibit the assimilation of calcium by the body.

In summary, jack bean can be used in grain fields, under orchard trees or to shorten fallow periods, but is not as vigorous as the velvet bean and should be used only when conditions are too severe for the velvet bean to do well. Under borderline conditions, perhaps mixtures of the two would function best.

Velvet bean (Mucuna spp. and other scientific names) is by far the most promising green manure that we have worked with in Central America. It covers the soil completely and then climbs as high as its support allows (up to well over 6 meters). It is highly palatable to animals and has found wide acceptance in our Honduras program areas as a coffee substitute. Especially encouraging is that there are at least 4 large areas where velvet bean use has spontaneously spread from village to village without any outside intervention (in Mexico to shorten fallows and in Honduras to intercrop with corn).

Velvet beans first cover the ground almost completely, then climb vigorously. Where corn stalks are present, it will eventually form a mat of leaves at about the top of the stalks, with little more than stems and pods underneath. Stems remain thin and nonwoody throughout the plant's life. The plant dies after it has set seed. [Ed: Seeing velvet bean growing to the tops of pine trees at ECHO prompts many to ask if it might not take over like kudzu in the southeastern USA. This might happen were it not that the plants die after seed set. It was a major U.S. crop for years, and I never heard of such problems.]

Sometimes velvet bean roots produce solid clusters of dark red nodules that are 4 cm. in diameter. We think that heavy nodulation occurs most frequently in infertile or sandy soils. Like jack bean, the velvet bean will volunteer heavily the second year if seed is allowed to mature and fall on the ground. In fact, farmers in Chiapas get good growth each year in their corn fields without bothering to reseed it. They harvest 4 T/Ha. of monocropped corn planted year after year on the same land under typical jungle conditions, using chemical fertilizer plus velvet bean.

About the only soils in which velvet bean has not done well for us are those that are waterlogged or have a pH of 4.5 or less. Like the jack bean, it needs to be planted in a field that is either sandy or has been cultivated within the last 3 years. Velvet bean will take a bit cooler climate than jack bean, but still does best at sea level and does poorly over 2,000 meters. In cool climates it will grow 3-4 months into the dry season, but is not as drought-resistant as jack bean. Velvet bean grows even more vigorously than jack bean under less harsh conditions, but in areas of severe drought, jack bean will out-perform velvet bean.

The velvet bean is presently our species of choice, in most cases, for growing in corn fields, rehabilitating depleted land, and weed control. It has been used in Guatemala and parts of Honduras to eliminate serious weeds such as nutgrass (Cyperus rotundus), Bermuda grass (Cynodon dactylon) and imperata grass (Imperata cylindrica). I am not aware of what is required to do this, though I would guess that the grass must be cut back and the velvet bean then allowed to grow a full 6 months in order to choke out the weeds.

It is an extremely good, fairly palatable high-protein fodder for most animals, especially cattle, and is eaten by virtually all animals except, sometimes, chickens. Thus, like the lablab bean, it can be an important source of high protein fodder well into the dry season, when many domestic animals are losing weight for lack of food.

We were taken off guard by the degree of acceptance of the dry beans as a coffee substitute. Having introduced it as a coffee stretcher (to be used 50-50 with coffee), we found that people were soon drinking it straight. Use is so widespread after just one year that a group of women is roasting and grinding the bean and selling some 40 pounds a week under the name "nutricoffee."

Like the jack bean, velvet bean is native to Central America. However, there are two kinds. The more common one has an extremely irritating itchy powder on the mature pod. Villagers who know this plant will not want to plant the non-itchy-powder varieties until they have been shown that the pods are harmless. We would under no circumstances recommend that anyone use the irritating kind with small farmers.

Slugs damage velvet bean in warm climates (though much less than regular dry beans). Rabbits, leaf-cutter ants (its only serious insect pest here) and iguanas are other pests. In some locations rats used the velvet bean stems to climb up and eat the corn. Planting the beans later or cutting its tendrils when it gets too large has helped with this problem. It must be watched and cut back if planted near trees.

Everything said above about planting jack bean also applies to velvet bean. However, fine tuning is needed to determine when to plant velvet bean in local corn fields. This is affected by speed of growth of the native corn, climate, soil fertility and existence of problems with rats. One should plant as soon after the corn as possible to get maximum velvet bean growth and weed control, but not so soon that the velvet bean outgrows the corn or causes rat problems. Especially in fertile or heavily fertilized soils, the velvet bean grows very rapidly and may even need to be pruned once to retard its progress.

Corn crops growing where velvet bean or jack bean have been incorporated can often do extremely well without any initial fertilization with chemicals, but will often show signs of nitrogen deficiency by tassling time. Farmers in our programs in Honduras almost always add a side dressing of urea to these crops. In general we recommend this practice where fertilizer is available and affordable. Over the long run, one would think phosphorous would also be needed, but in the short-run neither visible symptoms nor level of yields would indicate much problem with this element. Quite likely the increased organic matter is increasing the availability of soil phosphorous enough that deficiencies are not yet a problem.

In corn fields, the velvet bean produces an average of about 6-7 pounds of above-ground organic matter (wet weight) per square meter (30 T/Ha), but has produced twice that. The effect on subsequent plantings is roughly equal per pound to that of cow manure or half that of chicken manure, although this varies from field to field. When incorporated into the soil, the velvet bean often approximately doubles subsequent corn yields and when used as a mulch increases yields by about 35%. Even dry bean yields following velvet beans have shown yield increases of over 100%.

[Ed: Even though leaving the residue as a mulch has many benefits (erosion control, weed control, moisture retention), the greater effect on corn yields after incorporation might lead you to incorporate residues rather than leave them as a mulch. All nutrients probably become available in one season when incorporated, whereas they are more slowly released when left as a mulch, accounting for the greater effect. However, almost surely some or much of the remaining nutrients will benefit the second and subsequent corn crops. Roland and I asked during a regenerative agriculture conference at Rodale International for a perspective on this question. The consensus was that over several years the total amount of nutrients available for plants is about the same whether residues are left as a mulch or incorporated. We would welcome your input on this question. I recommend a no-till approach except in famine situations where immediate yield is imperative.]

Farmers in areas with enough moisture for two crops of corn or sorghum started doing the following. The green manure (velvet bean or jack bean) is intercropped with the first grain crop. After harvesting the grain they cut the residue and green manure down, leaving this on the surface as a mulch. The second crop is planted 20 days later with a dibble stick right through holes cut in the mass of dead velvet bean. There is usually a net saving of labor because planting and cutting of the green manure requires less work than the two weeding operations that are thus saved with the second crop. This is the sort of technology one dreams of, but rarely finds: net savings of labor, zero cash cost, decreased risk (the mulch gives some protection from erosion and drought), increased productivity, increased soil fertility and increased protein intake for animals or people.

In Togo velvet bean grew well and was incorporated into the soil 5 months before planting corn. There was virtually no response to the green manure. Our hypothesis is that the green manure was burned or leeched out. We are now testing whether under such conditions a green mulch (jack bean for instance) throughout the dry season will be able to reduce surface temperatures sufficiently to maintain organic matter. We have serious doubts about the claims that organic matter in tropical soils are impossible to maintain.

Recently villager nutrition groups have discovered that by toasting the velvet bean somewhat less than they do to make coffee, they have been able to produce a really passable hot chocolate. By grinding the flour finely, they have even been able to use a recipe for soybean cake to make "velvet bean cake." [See the chapter on Human Health for information on using velvet bean as a food source.]

The Lablab bean (Dolichos lablab or Lablab purpureus) is a legume very similar in appearance to the velvet bean, but even faster growing where soils are fairly fertile. It has not been as valuable to us because of its need for somewhat more fertile soils and occasional insect problems, but may well be important to us later on when the other green manures have raised fertility sufficiently. The lablab bean is almost as drought-resistant as the jack bean, is very shade-tolerant, and is among the most palatable of legumes for animals (definitely preferred over velvet bean or jack bean). Lablab beans grow well from sea level up to about 1,500 meters. They require well-drained soils.

Lablab beans start flowering after 3 months and continue most of the first year, producing seed as well as remaining green. If soils are deep enough and other conditions permit, it will grow right through the dry season. I have seen plants that survived 3 years in droughty areas of the central plateau of Haiti. [Ed: In the sandy soils at ECHO lablab beans get nematodes so badly that it is difficult to keep them alive an entire year]. It nodulates profusely, producing mostly white nodules. Whereas the velvet bean growth is reduced if it has nothing to climb, plants in thick stands of lablab beans will begin to climb up each other. Another difference from the velvet or jack bean is that the lablab bean can be cut off nearly at ground level and will grow again, although with somewhat less vigor.

Lablab beans are traditionally planted toward the end of the agricultural cycle in some villages in Honduras to provide dry-season pasture for animals. It is also edible, and in some places, such as Haiti and West Africa, is widely appreciated as a regular food. Young pods or immature beans can be eaten green (beans taste similar to a sweet pea-a white-seeded variety is best for this). Dry lablab beans can be substituted for dry beans in most recipes. [Ed: Young pods of some varieties are quite tasty when cooked. Dr. Andrew Duncan recently told me that he saw a variety with an exceptionally wide pod growing on sides of village houses in Bangladesh.]

Where it grows well, the lablab bean has produced a phenomenal 11 kg per square meter (110 T/Ha) of above- ground organic matter (wet weight). Though we have had problems with insect attacks, its growth is so vigorous that it still usually grows as fast as the velvet bean. It grows so quickly that it should not be planted in corn until at least two months after corn is planted. Because animals prefer it to almost anything else, lablab beans cannot be grown where animals run free.

In pure stands, lablab beans should be planted about 10/m2. We have not found a good system yet for planting in corn fields because of its rapid growth, but it should be possible with heavy pruning (which it withstands well). The lablab bean requires either a recently cultivated or a sandy soil.

Many other species and varieties may already be present in your area and better-suited than these species. Other possibilities for low elevations (0-1500m, warm) include: Clitoria ternatea (butterfly pea; very drought-resistant but small-leaved, not covering the soil well, grows well at sea level), Canavalia gladiata (sword bean, like jack bean), various native Vignas, Crotalarias, Cajanus cajan (pigeon pea), Pueraria phaseoloides (tropical kudzu, different from the temperate weedy species) and many others. For intermediate elevations (1500-<3000 m): Phaseolus coccineus (scarlet runner bean, 'chinapopo'; reseeds naturally, does not need pruning; see the excellent CIDICCO full-color report on this species, 48 pp., US$8), Melilotus albus (sweet clover; may be difficult to eradicate), Lathyrus nigrivalvis (choreque; Guatemalan highland crop for the dry season, produces much biomass, but requires very fertile soil and a few years to produce well in new areas; needs cold but is not frost tolerant; grown on fertile land 1800-2100 m) nonleguminous Raphanus sativus (forage turnip; very fast production of much biomass) and Avena spp. (oats), Pisum sativum (peas) and Vicia spp. For high elevations (>3000 m), options are much more limited: Lupinus mutabilis (tarwi; excellent fixer of nitrogen) and Vicia faba (fava bean, broadbean). There is much room and need for experimentation and developments on the scientific and community levels with additional species.

Continuing research needs. If you have been experimenting with green manures, CIDICCO, Roland Bunch, and ECHO would like to see whatever information you have put together. Among the most important subjects we need to learn more about are: (1) What legumes will work above 1,800 meters? (2) What additional plants will work at any elevation? (3) What GMs will work best under wet tropical conditions? (4) In what ways must these recommendations be modified for areas outside of the Caribbean basin area from which they have come?

We still need tremendous amounts of information on GM systems. We need to learn about additional species for intercropping with major crops, for rotation with other GMs, and species suitable for various niches. Much more data is needed on how to manage these GMs in different soil and climatic conditions and the best techniques for management of the system. Attention to how various species can be grown together is also needed.

[Ed: ECHO has small packets of seed of many (but not all) of these species available for trial. We usually have: velvet bean, jack and sword beans, lablabs, pigeon pea, butterfly pea, tropical kudzu, and fava beans. (If you have seed of other species available you can share, let us know and we will send you our plant import permit.) Please note that our packets are for small trial plots; we do not have large quantities. If you want to buy larger quantities we will try to send you a source. We also have the "90-day" velvet bean that was grown in the south- eastern part of the USA 50 years ago. At the time of the last corn cultivation farmers would plant this velvet bean. Both corn and beans were left in the field. Cattle were allowed to feed in the fields a couple of hours each day in the fall and winter, reportedly getting very fat. This variety is not sensitive to day length so produces 3 months after planting. The tropical kind only produces when days are short (flowering starts in November at ECHO). The 90-day kind has some of the itch-producing hairs Roland refers to, but not nearly as many as I have seen on the wild "pica-pica" in Honduras.]

INNOVATIONS IN GREEN MANURES (1995). Roland Bunch sent an intriguing report on his visit to the state of Santa Catarina in Brazil to see the work of EPAGRI. "It was, technologically speaking, the most impressive piece of work with small farmers that I have ever witnessed: highly innovative, aimed at a crying need throughout the third world, very popular with the farmers, widely disseminated, and with results in better economic standards among the farmers."

"Probably the most important issue of all is that we must get away from the escalating dependency on velvet bean (at least in Central America)." The following is abstracted from Roland's report.

The project has been continuing for 13 years, on both flat coastal areas and mountains. The technologies include contour grass barriers and orienting crop rows on the contour, but by far the most popular aspect of their work is green manures/cover crops (GMCCs). These plants are used to fertilize and condition the soil, usually left on the soil surface rather than buried. They are valued both as green mulches while growing and dead mulches after being cut. The vast majority of farmers use a traditional animal-drawn tool called a "rolo-faca" (knife roller?) which knocks over and cuts up the GMCC. Then with other animal-drawn instruments, they clear a narrow furrow from the mulch and plant their next crop. The resulting mulch both reduces or simplifies weeding and noticeably increases soil fertility. The majority of farmers who have used any of these systems for more than 5-6 years are no longer plowing, evolving from a minimum-tillage system to a no-till system. Seeds of the succeeding crop are merely hand-drilled into the soil. Some farmers' animal-drawn plows are rusting in abandonment.

The project works intensively with some 60 species of GMCC and have seen widespread adoption of about 25. We very much need to continue finding new species and varieties of GMCCs. Also, if we are to avoid having more and more insect and disease problems with GMCCs, we must practice rotation with them just as we rotate major crops. Furthermore, we must avoid becoming dependent on one or two species, lest we fall into the trap that Leucaena-based programs did in Southeast Asia when psyllid insects defoliated thousands of hectares of the world's most successful alley cropping. More specifically, for those many programs totally dependent on the velvet bean as a green manure crop, it should be noted that in southeastern Paraguay, a fungus has wiped out two of the four varieties of velvet bean that were previously used in the area.

Maintaining soil cover is much more important in preventing erosion than terraces or soil conservation barriers, live or dead. Roland says, "This is the first program I have seen which took this fact to heart, and was able to convince the farmers of its value through their own observation and experience. Thus, one more nail has been pounded into the coffin of our old bag of tricks, which featured contour ditches, grass or tree barriers, and contour rock walls. We are not ready to abandon these practices entirely, but certainly we are in the middle of a process of re-examination which will probably result in a major de-emphasis in our use of at least rock walls and contour ditches."

"The overall quantity of biomass is more important, relative to amount of nitrogen fixed, than we had previously assumed." For example, both oats and turnips are widely used as GMCCs. This makes sense if covering the soil and achieving a no-till system are as important to the farmer as are supplying nutrients to the soil.

The possibilities of GMCCs to fit into a wider and wider number of cropping systems was confirmed. Farmers were using GMCCs in cropping systems based on corn, onions, cassava, and fruit trees. Also Roland was shown photographs of GMCCs associated with wheat, grapes, tomatoes, soybeans, and sorghum. There is a tremendous need for farmer experimentation to discover new species and ways to adapt to differing agricultural systems. No agronomist-staffed research stations will ever be able to investigate and refine all the possibilities.

Probably the single most important result of the Brazilian work is that by eliminating the need for most of the weeding and all of the plowing, the small farmer is at much less of a competitive disadvantage with the large, mechanized farmer. Small farmers, especially on hillsides, were never able to carry out the really heavy and expensive labors of plowing and weeding as cheaply as could the mechanized farmer. The answer lies not in the mechanization of these jobs, but in their elimination.

Roland cites a study by Flores and Estrada which compared no-till velvet bean-based system with a neighboring mechanized modern system in Honduras. The velvet bean system was less productive, but the costs per ton of corn produced were 30% less.

JACK BEAN REPORT from Don Mansfield in Mali: "I planted jack beans (Canavalia ensiformis) in terrible soil (red clay with very little top soil). They were planted September 26 and are growing like mad, yet we have had no rain since October 9. I planted them as a ground cover for land just cleared and a green manure. We have been staking the ox there. He eats the grass and does not touch the jack beans. I am really surprised and pleased at how well they are doing. I had the seed and figured I had nothing to lose by planting them."

AN OBSCURE USE FOR JACK BEANS (for your interest only). Terry Waller sent us an article in the San Angelo Standard Times about a Texas couple that grows 5 acres of jack beans every year. A chemical company in Oklahoma, "Organon Teknica Corp., uses them to make the chemical that filters blood in a dialysis machine. They say jack beans are the only way they can make it."

COMMERCIAL LABLAB BEAN VARIETIES. Lablab beans (Dolichos lablab) are one of the "big three" green manure crops that our readers have been requesting since Roland Bunch's articles in EDN. Because so many of you are now growing lablab beans, we thought you might like to compare their growth to two top commercial varieties in Australia. We purchased varieties 'Rongai' and 'Highworth' from Sauers seed company (P.O. Box 117, Rockhampton 4700, Queensland, AUSTRALIA; fax 61-79-22-2219).

The catalog describes the two. 'Rongai' was derived from the original introduction of lablab from Kenya in 1952. It was released in 1962. It has white flowers and brown seeds. 'Highworth' came from southern India. It was selected from a large range of lines for its early flowering, high seed yield and satisfactory dry matter production. Both varieties have similar vegetative growth, but Highworth flowers are purple and the black seeds are slightly smaller. Flowering begins 3-4 weeks earlier than Rongai in northern Queensland and up to 6 weeks earlier in Central Queensland. Pod maturity of Highworth is more uniform and because the pods are borne well above the foliage, seed harvesting is simplified and seed yields are higher.

SUNN HEMP AS GREEN MANURE. Fr. Gerold Rupper reports that sunn hemp is receiving widespread acceptance as a versatile green manure in East Africa. His sunn hemp seed bank distributed 150 tons of seed last year. He sent information about his work with sunn hemp in Tanzania, as well as seed of the species he grows, Crotalaria ochroleuca.

Though sunn hemp has a totally different growth habit than the green manures we have featured in the past, it has many of the same uses. It is a vigorous upright legume growing 2 meters tall. (The velvet bean, jack bean and lablab bean are all vines.) Among other things, they use it to improve the soil, kill weeds, feed livestock, and control erosion.

It is especially suited for fruit groves because, unlike vining ground covers, continual vigilance to keep it from covering the trees is not necessary. They are using it with banana, plantain, citrus, and coconut. It can be cut at any time and left in the field as mulch. If it is cut one foot (30 cm) from the ground it will grow a second time. He stresses that not less than 10 kilo of seed per acre must be planted.

Fr. Rupper wrote, "In Hanendi, sunn hemp was planted in an orchard affected badly by insects. When it had grown a bit, the insects left the trees and started to live on the sunn hemp. When the sunn hemp was cut for mulching, the insects returned to the orange trees." "Just this week we were informed that insects which attacked the freshly planted maize moved to inter-cropped sunn hemp, ate the roots and are perishing."

Crotalaria is known to contain toxins, but this variety is free of toxin (except perhaps the seed) and is fed to livestock. It is cut about 3 months after planting. It is best cut in the morning, but keeps until evening. Later in the season cattle can be allowed to graze in the sunn hemp field, but they must not be allowed to spend more than about one hour in the area. [He does not say why.] Later he wrote us that "this year our farmer stopped cutting sunn hemp, instead allowing his 120-cow herd to feed freely in fields after first spending an hour in a grass field. The cows even ate dry stems." Fr. Rupper also says that the seeds should not be stored in a closed room where people are working.

The seeds are used to keep weevils from stored rice and maize. Sunn hemp seeds are spread over the ground and bags put on top of the seeds. This procedure is continued, layering sunn hemp seed and bags of stored grain. After about 9 months, the process must be repeated. As with velvet bean, farmers are especially appreciative of its usefulness in controlling weeds and improving the texture of the soil. He tells farmers, "If you have no chemical fertilizer when the season starts, plant sunn hemp between your food crops. If fertilizer arrives you may still be able to use it. If not, use sunn hemp and you will at least get a modest crop." Other uses are applying the dry stems and any husks to trees or gardens as mulch, or as bedding for livestock.

The seeds, about the size of millet, are mixed with two parts of coarse sand and broadcast by hand. They do not need to be covered, although it might be well to draw a branch across the newly planted field. They sprout after a few days and develop a strong root. Growth is rather slow until they reach about one foot, then they quickly grow to 2 meters or more. It is fairly drought resistant, recovering well when rains return. Plants bear seed after 3-4 months and die after 6 months. However, if they are cut back to about one foot (30 cm) above the ground, they again develop new leaves.

If planted densely in a well-prepared field, no further work is needed (except to keep out animals). Sometimes it is interplanted with maize. Some species of Crotalaria are useful in suppressing nematodes, but we do not know if this is one of them.

Another species of crotalaria, Crotalaria juncea, was released by the University of Hawaii (but no longer distributed by them; now available from Hikiola Coop, P.O. Box 231, Hoolehua, HI 96729, USA; phone 808/567-6774). 'Tropic Sun' is included in rotation with vegetables, ornamentals and others to add nitrogen, organic matter, suppress weeds, control erosion and reduce root-knot nematodes. In 60 days it can produce 145 pounds of nitrogen and 3 tons of dry matter per acre. Seed should be broadcast at the rate of 40-60 pounds per acre and covered

1/2 inch deep. High populations make the stems more succulent and hence better for incorporation into the soil. If allowed to grow too tall, stems become fibrous and difficult to deal with. Seeds can be inoculated with cowpea inoculant to maximize nitrogen fixation [presumably not needed where cowpeas are commonly grown]. It also lacks the poisonous alkaloids that make some Crotalaria species poisonous to livestock.

ECHO has trial-size packets of both species. For larger quantities of C. ochroleuca write to Fr. Rupper; St. Benedict's Abbey; P. O. Peramiho, TANZANIA, East Africa. (Seed is $7 per kilogram including postage and he always offers phytosanitary certificates.)

TROPICAL KUDZU USED AS GREEN MANURE IN ZAIRE. Pete Ekstrand just visited us and had this account from the Paul Carlson Medical Program in Zaire. They have found that Pueraria phaseoloides (tropical kudzu or puero) grows vigorously and can even smother the vigorous native imperata grass if the grass is manually bent over. (This is not the same kudzu, P. lobata, that took over so much land in Alabama and elsewhere.) They then cut circles perhaps 2 meters wide and plant fruit trees, coffee etc. in the middle. It had not rained for 60 days when he visited and the ground in the circles was hard and dry. But one arm length under the ground cover the soil was moist and could be molded with the hand!

VELVET BEAN SUCCESS IN THE REPUBLIC OF BENIN. Velvet bean, Mucuna spp., has probably had more impact on farmers lives than any plant distributed from our seedbank. For review: velvet bean is an extremely vigorous vine that grows well in moderately poor soil, is drought resistant, and fixes a lot of nitrogen on its roots. It is interplanted with corn as a green manure. Soon after the corn matures, it covers the entire field, killing weeds. It can even kill vigorous grasses like imperata grass. It is cut back and left in place just before corn planting time. This kills the vine, which now protects the soil from erosion, retains moisture, and eventually turns into compost.

How effective can it be? Tom Post reported that in Belize it had doubled and, in some cases even tripled, corn yields. A Project Global Village publication in Honduras reported up to 4-fold increases in corn yields. The amount by which velvet bean can increase yields clearly varies greatly from place to place. If the soil is sufficiently depleted, it has the potential to make an enormous difference.

The latest annual research from the International Institute for Tropical Agriculture in Nigeria reports on their experience in Benin. Demonstration plots of different kinds were established in farmers' fields. Groups of farmers met periodically to observe the results and to discuss what experiments they would want to do on their own fields. They were especially impressed that velvet beans could smother young shoots of the vigorous weed "spear grass" (Imperata cylindrica). Farmers harvested 80% more corn with velvet bean than on continuously cropped land. Farmers that chose an alternative experiment (pigeon pea) had only a very modest improvement.

Next farmers with "completely depleted fields" were given two optional experiments: plant acacia trees for a multi-year fallow or velvet bean. Many planted velvet bean one month after sowing corn, during the first rainy season, then let it grow into a dense cover during the second rainy season. The results were dramatic. They recorded, on average, a 10-fold increase in corn yield (from 200 to 2,000 kg per hectare). National extension authorities are now applying this technology in all zones where soils are depleted and imperata is a problem.

The article ascribes the success of the effort to several factors. Farmers were not just involved in the experiments but also in choosing which experiments to do. A range of options were presented. Farmers had a chance to see demonstration plots showing the effects of technologies before they made a selection. They were not simply told about hypothetical benefits and asked to make a selection. Finally, the effect of velvet beans on corn yield plus the bonus of imperata control had a decisive impact.

LEGUME COVER CROPS IN ORCHARDS OR PLANTATIONS. This is the theme of "Cover Crop News" #7. A brief summary of the insightful six-page report follows. For a copy or to receive this bulletin (US$1.50/issue, published twice a year), write CIDICCO, Apdo. Postal 4443, Tegucigalpa MDC, HONDURAS, Central America; phone 504/32-7471 or 39-9870; fax 504/39-9896; e- mail cidicco@nicarao.apc.org.

Since the early 1900s legumes have been used as cover crops in oil palm plantations in Asia. More recently it is being evaluated for other trees: soursop (Annona muricata) in Costa Rica, citrus in Honduras and Surinam, bananas in Panama, etc. Primary benefits are controlling weeds, reducing production costs and use of chemicals, and increasing yields.

The largest oil palm plantation in Honduras has had an aggressive program of intercropping legumes for 15 years (at least 1,000 hectares). Weeding is one of the greatest expenses in the early years of establishing oil palms. They begin producing after three years, but it is six years before the canopy is dense enough to restrict weed growth. Many fruit trees never provide enough shade to substantially restrict weed growth.

Tropical kudzu (Pueraria phaseoloides) is the most commonly used legume. Seeds are small and slow to emerge, so one must start with a weed-free field, planting 5-8 kg of seed/ha. Full soil coverage occurs in about 10 months, so some weeding is required. Once established, the vine tends to climb trees. Cutting circles around the trees is the main labor in established fields.

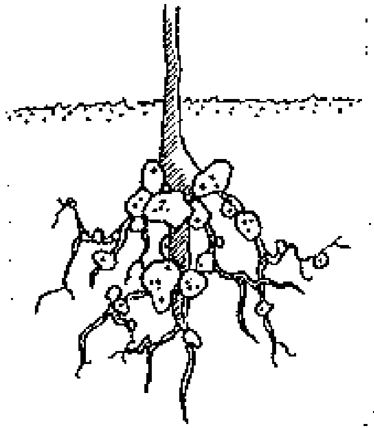
There is so much shade in an established oil palm plantation that kudzu growth is reduced. At that time a more shade-tolerant legume, Desmodium ovalifolium, is planted at this particular plantation. A further benefit is that it does not climb trees. In Belize, "A privately owned farm called Parrot Hill operates several hundred hectares of citrus plantations covered with Desmodium."

Often farmers grow corn between rows in a new plantation. In this case, the legume of choice is velvet bean because it is much faster to establish. The drawback to velvet bean is that its vigorous growth requires much more frequent pruning around trees. [At ECHO velvet beans easily reach the tops of pine trees, though they have never hurt the trees.] CIDICCO is a networking organization. If you have had experience in this area, they (and ECHO) would like to learn details from you, especially from readers in Asia.

Fertilizers

"WHAT ABOUT RHIZOBIA INOCULANTS? I don't recall any mention of them in the 'Seeds Available from ECHO' listing. Isn't it likely that many of the legume seeds will need rather specific rhizobia inoculants at planting time?" wrote Bob Tillotson in Thailand. "Does the seed [velvet bean] need to be inoculated to fix nitrogen or will it naturally do it on its own?" from Jim Triplett in Guam. Similar questions regarding legume inoculation come up often. The following attempt to answer these questions is based on an article by Dr. Paul Singleton with NifTAL which was sent to us by one of our readers, Brian Hilton. The article, "Enhancing Farmer Income Through Inoculation of Legumes with

Rhizobia: A Cost Effective Biotechnology for Small Farmers," addresses a series of questions. We will summarize these and add a few others.



Rhizobia live in nodules on the roots and can be easily seen

What are rhizobia and what do they do? Rhizobia is a genus of soil bacteria that infect the roots of legumes and can fix (make available to the plant) atmospheric nitrogen. Unlike disease-causing bacteria, rhizobia enter into a symbiotic relationship with the plant. The legume provides the bacteria with energy and the bacteria provides the legume with nitrogen in a form it can use.

Does one rhizobium work with every legume? No, rhizobia are selective and grouped according to which legume species they will colonize. The rhizobia of some species, e.g. leucaena, are very specific. Others cross-inoculate many species. For example the "cowpea family of inoculant" will inoculate Acacia albida, Cajanus cajan (pigeon pea), Desmodium spp., Lespedeza spp., Mucuna spp. (velvet bean). Some species, such as peanut, called "promiscuous," can be inoculated with any of a number of rhizobia. Often one rhizobium strain will provide some biological nitrogen fixation (BNF) but will be less effective than another. Unless some strain of inoculant suited to the legume species you are growing is present in the soil, no BNF will take place.

Which of my crops are most likely to respond to inoculation? Responses are likely from species whose rhizobia are quite specialized such as soybeans and leucaena. Areas with a distinct long dry season of 6-8 months are also likely to respond due to existing rhizobia populations dropping off more quickly under these conditions.

How do I know if I need to inoculate my plant? Rhizobia live in nodules on the roots and can be easily seen. Well nodulated legumes will have nodules on the tap root. (Dig the plant and remove the soil carefully or the nodules will fall off.) Not all nodules are effective, however. Cut several nodules in half. Nodules that are effectively fixing nitrogen will usually be red or pink inside.

How are rhizobia introduced? Most commonly legume seeds are coated with the appropriate inoculant just prior to planting. A sugar or gum arabic "sticker" is used to attach the powdery inoculant to the seed. If healthy, nodulating plants of the same species are already growing in the area the proper rhizobia should already be available and need not be purchased. Just add about 5 g of soil from such a plot to each hole as seeds are planted.

Can I maintain my own inoculant? Yes. After a successful crop, soil will always retain some inoculum until the next season. Replanting the same species in the same soil year round will serve to increase inoculum for that crop. But, this practice may also increase the occurrence of some diseases.

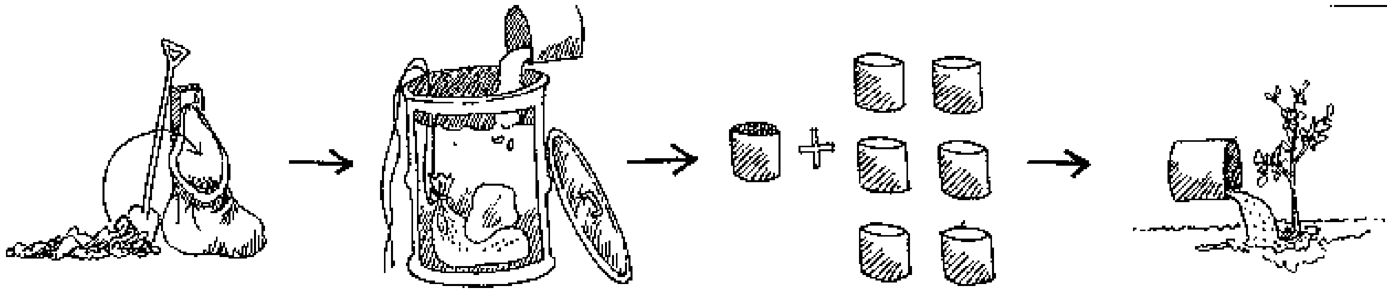
Why doesn't ECHO carry inoculant for the legume seeds it distributes? This would seem to be the wise thing to do. However, it is challenging enough to preserve and monitor the viability of our stored seeds.

Viability of inoculum is even more difficult to monitor and maintain which is why we leave this enterprise to those set up to do the job well.

How much rhizobium is needed to inoculate a seed? It takes about 100 grams of inoculant to sufficiently treat one pound of leucaena seeds. A hectare of soybeans requires 286 grams of inoculant. Quality is more important than quantity. The best inoculant contains a billion rhizobia per gram, but it doesn't take long for quality to drop. This is why inoculation is done just prior to planting. Since you can't tell if inoculant is good or bad by looking at it, care should be taken to purchase from a good source and handle it properly. Inoculant should be protected from heat, light and desiccation and used as soon as possible. If a cool storage area is not available, a pot buried in a shady area is a good option. If transportation is required, a container covered with a damp cloth works well.

Where can rhizobia be obtained? Many countries manufacture inoculants for a number of crops. Contact your local agricultural extension agency or national department of agriculture to see if they have the inoculant you are looking for. If it needs to be imported, probably the best source for trees would be AgroForester Tropical Seeds (P.O. Box 428, Holualoa, HI 96725, USA; phone 808/326-4670; fax 808/324-4129; e-mail agroforester@igc.org). Liphatech Company (3101 West Custer Avenue, Milwaukee, WI 53209, USA; phone 800/558-1003 or 414/351- 1476; fax 414/351-1847) has inoculant of many species, including GMCCs which are not trees. ECHO has a running list of sources we have come across to date; let us know if you cannot find a source. More information on this topic can be obtained by contacting the University of Hawaii NifTAL Center (Nitrogen fixation by Tropical Agricultural Legumes; 1000 Holomua Road, Paia, HI 96779, USA; phone 808/579-9568; fax 808/579- 8516; e-mail NifTAL@.hawaii.edu). Other possibilities include the international agricultural research center nearest you (e.g. CATIE, CIAT, ICRISAT, IITA, IRRI, etc.), UNESCO (Microbial Resource Centre, Karolinska Institute, 10401 Stockholm, SWEDEN), or the BNF Resource Centre (Soil Microbiology Research Group, Rhizobium Building, Soil Science Division, Department of Agriculture, Bangkok 10900, THAILAND; fax 662- 5614768). Some concluding remarks: Each situation is different. If farmers can obtain inoculant quickly and reasonably it can be a low-cost input with high returns. If planting something like soybeans for the first time in an area, special efforts should be made to obtain proper inoculant. Legumes will grow without rhizobia, they will just require mineral sources of nitrogen like other plants. Even with proper inoculation, factors like low phosphorous, low pH and insect damage will limit yield. It should also be noted that it can take up to 20 days for biological nitrogen fixation to get going, so an application of nitrogen just after germination can help even if rhizobia are present.

HOW ADEQUATE IS CHICKEN MANURE TEA AS A FERTILIZER? One aspect of ECHO's ministry is behind the scenes for most of our readers. We help college professors and students in the sciences identify research projects that would be of benefit to the small farmer. Several ideas that could be done at an undergraduate level are written up in what we call Academic Opportunity Sheets. Nathan Duddles, while an undergraduate at California Polytechnic University, did an outstanding job answering the above question. I should think his 100-page report is of master's thesis quality.



chicken manure tea as fertilizer

He placed fresh chicken manure in a burlap bag, added a rock to make sure it did not float, and set it in water in a 35 gallon garbage can. If you were making such a tea, how long would you let it set to get out most of the nutrients? Nathan measured nitrogen in the "tea" each week and found that with 20 pounds of manure the maximum was nearly reached after only 1 week. It took 3 weeks with 35 and 50 pounds. However, the concen- tration apparently became so high that bacteria stopped working because he got even less nitrogen with 50 pounds than with 35 pounds.

How does the tea compare to an ideal hydroponic solution? He measured several nutrients in the tea made from 20 pounds after 4 weeks. After diluting it to a fourth its original concentration he compared it to one such standard hydroponic solution. The tea concentrations followed by the standard are: total nitrogen (219; 175), nitrate (4; 145), ammonium (215; 30), phosphorous (54; 65), potassium (295; 400), calcium (6; 197), sodium (62; 0), magnesium (0; 2), iron (0; 2), manganese (0; 0.5), copper (0; 0.03), zinc (0.05; 0.05). The major nutrients and zinc are adequate. Only calcium and tiny amounts of iron, manganese and copper would need to come from another source. Unless you are growing hydroponically where all nutrients must come from the tea, these should be available from the soil or compost. He suggests that lowering the pH from 7.3 to near 6 might provide some of these, or some might come from dilute sea water.

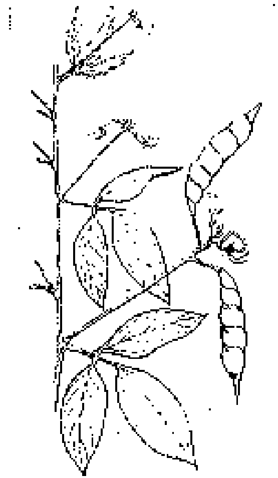
Total nitrogen was ideal, though it would preferably be in the nitrate rather than ammonium form. However, the tomatoes grown with the tea or a hydroponic solution (somewhat different and less ideal than the one above unfortunately) grew only marginally better with the chemical preparation.

Tomatoes were grown in wood chips to see how the tea would work with our rooftop gardens and in sand or sawdust for comparison. Growth in wood chips was superior in every case, apparently because the other two were so wet that roots could not get enough air. He analyzed the concentrations of nutrients present in plant tissues and found that the only significant difference was that plants grown with manure had more sodium. The micronutrients must have come from the growing medium. We have a Technical Note on this subject for those interested in more details.

HOW TO MAKE A FISH EMULSION FERTILIZER. We had been asked this question but I never knew the answer until Organic Gardening answered it in their February 1990 issue. It does not make me want to go to my suburban home and try it, but I could see its use on the small farm.

"Place fish scraps in a large container and add water. Cover the top securely with a cloth plus a wire screen to keep out animals and insects. Put the container in a sunny location to ferment for 8 to 12 weeks. You can add a small amount of citrus oil or other scent to mask some of the odor, but be sure to keep the container where your neighbors won't complain. Try to avoid spilling any fish scraps or fishy water on the ground, where they will attract animals. When finished, a layer of mineral-rich oil will float on the water, and fish scales will have sunk to the bottom. Skim off the oil and store in a tight-fitting container. To use, dilute 1 cup of oil with 5 gallons of water. Your homemade fish emulsion will be rich in nitrogen, phosphorous and many trace elements, but generally low in calcium."

PIGEON PEA AND CHICKPEA RELEASE PHOSPHATES. (Based on an article in International Agricultural Development, April 1992.) We all know that legumes such as these two plants add nitrogen to the soil. Now scientists at ICRISAT in India have shown that they make available more phosphates. They do not add phosphate to the soil, but rather break up phosphate compounds in such a manner that phosphate that was already present but unusable by plants is now available. If you work where phosphate is one of the most limiting nutrients (a common situation in tropical soils), you might want to work these crops into your rotation.



pigeon pea release phosphates

How do they work? Studies show that the roots of pigeon pea exude acids (piscidic acid) which release phosphorous when it is bound up with iron. Chick peas release another acid (mallic acid) from both roots and shoots. In calcareous soils (alkaline soils with high calcium content), this acid breaks up insoluble calcium phosphate. Normally this release would only occur if the pH of the soil were lowered.

Both plants "are deep rooted, so their ability to release more phosphates means that valuable nutrients are being brought up from the deeper soil layers. Residues from both crops are adding extra phosphates which will benefit the crops which follow in the rotation. It is possible that some varieties ... exude more acid than others. So this trait could be another characteristic for selection [by plant breeders]."

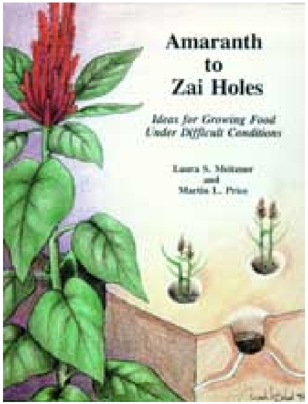
PLANT TISSUE NUTRIENT TESTS AVAILABLE AT OHIO STATE UNIVERSITY. This technique is more sophisticated than most of you will require, but readers do occasionally ask us where they can get leaves of a plant analyzed to see what nutrient is causing a certain symptom. "Are the leaves yellow for lack of nitrogen or iron?" The theory behind this technique is that the ideal place to look for a nutrient deficiency is in the plant itself, rather than the soil. For example, even though a soil test might show that a particular nutrient is present in the soil in adequate amounts, a deficiency of that nutrient could still be causing the deficiency symptoms if for some reason (e.g. high pH) the plant could not take it up. A foliar spray with that nutrient might solve the problem.

I read in a newsletter that the Ohio State University experiment station offers this service at a good price. I wrote asking how one could get soil or plant material into the States for analysis. Professor Maurice Watson said you need to obtain a customs permit number from them, then send samples to them directly for analysis. No doubt many other Land Grant Universities offer similar services.

The standard plant tissue analysis for nitrogen, phosphorus, potassium, calcium, magnesium, manganese, iron, copper, zinc and boron costs $12.00. The standard soil test for pH, lime deficit, available phosphorus, exchangeable potassium, calcium and magnesium, cation exchange capacity and percent base saturation costs $6.00. Many other tests are offered, such as organic matter, available minerals, and heavy metals. Write the Ohio State University; R.E.A.L.; Ohio Agricultural Research and Development Center; Wooster, OH 44691; USA; phone 216/263-3760. Prices quoted were in effect April 1995. Be sure to write them for current prices, detailed instructions on how to take samples, how much to send, etc. before submitting any samples.

"FEEDING AND BALANCING THE SOIL" is a five-day short course taught by Neal Kinsey, author of Hands- On Agronomy, about $475 registration fee includes lunches. Offered annually (during July in 1995), at Little Creek Acres, a non-profit demonstration farm for sustainable agriculture. Other courses are offered from time to time. For information write Center for Living in Harmony, 13802 Little Creek Lane, Valley Center, CA 92082, USA; phone 619/749-9634; fax 619/749-0720.

INTERNATIONAL AG-SIEVE is "a sifting of news in regenerative agriculture." This publication changed format in 1995 to 4-page information sheets on specific topics in ecologically sound agriculture. Issue #1 was on vermicomposting (using worms to produce high-quality fertilizer); issue #2 discussed the benefits of soil- improving legumes. Each edition has basic information, contacts, and publications on the theme. Readers are encouraged to follow up specific questions with the professional references listed. An index of available issues is sent periodically to individuals on the mailing list, and readers select the issues they wish to receive (about $4/issue). They hope to publish 12 issues per year. Send your name, address, and a brief description of your work to International Ag-Sieve, Rodale Institute, 611 Siegfriedale Rd., Kutztown, PA 19530, USA; phone 610/683-1400; fax 610/683-8548.



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

7: Water resources

Life and agriculture are dependent on water. One of the most frequent questions ECHO receives from the field reflects the need for strategies to produce food in dryland areas or in the dry season. The erratic and unpredictable rainfall in much of the tropics makes food production difficult; months of drought bake and harden the soils, so the torrential rains which follow lead to erosion. People without sufficient water for cooking and personal use are not able to irrigate crops during the dry season. This chapter gives some ideas on soil and water conservation in times of water shortage and seasonal abundance.

Arid region farming primer

by Dr. Frank W. Martin

INTRODUCTION. In every region of the world it is necessary to find or develop appropriate techniques for agriculture. A large part of the surface of the world is arid, characterized as too dry for conventional rain fed agriculture. Yet, millions of people live in such regions, and if current trends in population increase continue, there will soon be millions more. These people must eat, and the wisest course for them is to produce their own food. Yet, the techniques are so varied that only a very large volume would cover the entire subject. This publication is only a primer, an introduction to appropriate techniques. More extensive treatments are mentioned in the bibliography. In many cases the most suitable techniques for a particular region may be those already developed by the local inhabitants. In some cases it will be difficult to improve on local techniques, but at times even simple and inexpensive innovations may be almost revolutionary. This bulletin suggests that one must begin to improve local agriculture in arid zones by learning what is already there. Then both techniques and plants that may be useful in specific situations are suggested.

Definitions and degrees of aridity. "Arid" implies prolonged dryness, and is used with respect to the climate and the land below it. In such regions the ability to produce agricultural crops is restricted. Usually on arid lands the potential evaporation of water from the land exceeds the rainfall. The land may be characterized according to the degree of aridity as dry forest, chaparral or brushland, grassland or savannah, or desert.

"Arid" does not adequately characterize the soils, however, for they may vary in many ways. Often they are alkaline or saline.

Several degrees of dryness must be recognized. The first is where the dry climate is modified by seasonal rainy seasons. In such a region it might be possible to produce a wide range of annual crops during the short rainy season, enough to sustain animals and feed mankind, although few food or feed trees might be feasible without special techniques. The second situation is a year round aridity, sometimes modified by light or irregular rains, which might make production of crops impossible. The third situation is where water is brought in by wells, canals, or other means so that normal agriculture can exist, in spite of the aridity of the climate. This primer concerns the first two situations, but not the third. There are techniques suitable for all arid regions.

Principal arid regions of the world. Arid regions are often extensive, but in the tropics it is common, even on a small island, to find arid regions near regions of abundant rainfall. The large arid regions are:

NORTH AMERICA
The Sonoran Desert

Much of Western USA

CENTRAL AMERICA
The Pacific Coast

AFRICA
The Sahara Desert
The Sahel
The Kalahari Desert
East Africa

SOUTH AMERICA
The Atacama Desert
The Serrano of Brazil

ASIA
The Middle East
The Indian or Thar Desert
The Namub Desert
The Karakum Desert
The Gobi Desert

AUSTRALIA :
The Central Deserts

However, while the above mentioned regions may constitute the most arid regions, nevertheless, there are many more areas, large and small, where aridity is a problem.

PRINCIPAL PROBLEMS OF AGRICULTURE IN ARID REGIONS

Water. Water is absolutely necessary for all plant and animal life. Plants have evolved that are capable of living and reproducing in semi-arid, arid, and even desert regions. However, as aridity increases, fewer and fewer species are adapted, and the potential biomass is reduced.

Plants are adapted to aridity by several mechanisms. There are plants with a short life cycle that can germinate, grow, and produce during a very short period of available moisture. There are plants with deep or extensive root systems which have the ability to gather water over a wide area. There are plants which store up water in their tissues and release it very slowly. There are plants that are protected from water loss by wax or other impediments. There are plants with very small or narrow leaves, thus reducing water loss. There are plants in which the tissues themselves can withstand much desiccation without dying. Crop plants in arid regions may have any or a combination of such mechanisms.

Water that falls in arid regions may be of little use for crop plants because the amount is too small to penetrate the soil sufficiently, or it may run through a porous soil too quickly, or it may run off too quickly. Furthermore, weedy species may be so adept at utilizing scarce water that they rob the water from crops. On the other hand, some soils store water so efficiently that it is possible to grow crops over an extensive period of drought.

Water from rivers, lakes and wells in arid regions may have problems of quality, especially the presence of excess minerals. The use of irrigation water might lead to the accumulation of salts in the soil resulting in alkalinity or salinity, which might then limit crop production. The removal of salt from the soil is very difficult.

In all arid regions a major challenge is to manage water appropriately. The purpose of such management is to obtain water, to conserve it, to use it efficiently, and to avoid damage to the soil.

Heat and Wind. The major effects of heat and wind are to increase the rate of evaporation, and thus to increase the effects of aridity. Wind may also cause mechanical damage to crops. Both are combatted by changing the microclimate. The effects of winds can be reduced by windbreaks (lines of trees perpendicular to the direction of prevailing winds). Some useful tall species are tamarisk, casuarina, and eucalyptus. A windbreak can consist of trees and other plants of varying height. As a general rule, a windbreak is effective over an area 2.5 times the height of the tree. One must remember, however, that a windbreak may also rob crops of light, water and nutrients. Thus, the advantages of a windbreak must be weighed against the disadvantages in any particular environment. Windbreaks can also be constructed of non-living materials, which are likely to be expensive.

Heat is received principally from the sun and can be reduced by shading. But, shading also reduces the yields of plants. A light shade such as that below a coconut planting or a protective screen or lathwork can be useful in reducing heat and retaining moisture, with only a minimum loss of yield.

Soils. Soils of the arid tropics are highly variable, as they are in any climate. Nevertheless, it is possible to make some generalizations about such soils. Because of the low rainfall and consequently reduced plant growth, organic material is produced slowly. Yet, again because of low rainfall, it may be broken down slowly as well. The amount of organic material in the soil, and thus the potential fertility, is likely to be high in semi-arid zones, low in deserts.

Because of low rainfall in desert soils, minerals derived from breakdown of rocks are not leached from the soil. In some cases where the soil is periodically flooded or irrigated the soil might be saline as well. Such soils support few crops. Soils of the semi-arid and arid zones might support few plants on the surface, but a good part of the biomass might be in the soil itself as roots. Shrubby desert plants often have very hard woody roots that may be a physical barrier to agriculture.

Disease and Pest Problems. Arid regions have their fair share of disease and pest problems. However, these may often be quite different from those of wetter regions. Nematodes are often a severe problem in sandy soils. No general rules are useful, and indeed, agriculture anticipates diseases and pests, and their parasites as well.

AGRICULTURAL TECHNIQUES FOR ARID LANDS

Many of the techniques for agriculture in arid lands are not very different from those in other climatic zones. The unique problems of arid lands are almost entirely related to water or its effects over long or short times. Therefore, the discussion here revolves around two questions: "How to capture existing water," and "How to use water wisely."

How to Capture Existing Water. Much of the water that falls on arid lands is lost by runoff, deep penetration into sands, or by evaporation. Runoff can be captured for later use in natural or nature-like ways, or in manmade structures. These include the following:

1. Furrows, and diking of furrows, ditches, and pits following contours to slow the runoff of water and permit deeper penetration.

2. Similar structures reinforced by bench terraces, vegetative strips, or trees for alley cropping.

3. Crescent-shaped basins arranged to gather water for one or more trees.

4. Reservoirs of water, such as natural or constructed shallow basins along roads which capture runoff, earth structures that lead water into

aquifers (underground streams), rock or clay-lined underground basins.

5. Other man-made structures. These include cisterns (household or community sized clay, stone, or concrete tanks, check dams (small structures that impede water movement in a stream), and conventional dams.

How to Obtain New Water. In many arid regions water can be obtained from wells. The depth of the well necessary to obtain water may vary a few to thousands of feet. Water in wells is either fossil (stored over impermeable layers for thousands of years), or from water that has entered the soil from rain, and is therefore stored rainwater. Both sources of water are limited and can be exhausted.

New water is also obtained by condensation from the air, either onto metal screens or plastic (the principle of the solar still) or onto foliage. Ingenious systems can be developed to capture this condensation. This source of water depends on nighttime temperatures that lower to the point of condensation.

How to Conserve Existing Water. Water that is conserved is just as valuable as water that is obtained, and conservation is one of the best strategies for arid zones. There are many techniques, here presented only as lists.

At the level of the home: Reduce water use in the home. Capture gray water (from kitchen and bath) for later use in the garden. Use overflow from septic tanks to irrigate trees.

On the farm or garden: Reduce evaporation with windbreaks and light shade. Plant in the best soil, and lead runoff water to it. Plant in furrows, pits, or swales. Establish plants in a nursery in pots, when feasible, for later transplanting. Keep the soil rich in organic material. Use drought resistant crops or varieties, when possible. Maximize use of trees that produce food in arid regions. Plant during appropriate seasons. Use mulch, but not in excess. Irrigate efficiently (usually the most efficient system is drip irrigation). Keep weeds down. Eliminate crop plants as soon as they finish producing.

Other techniques: Hillside farming. The special aspect of hillside farming that merits attention here is that water rapidly runs off and often causes erosion. Thus, hillsides can be arid even in an otherwise wetter climate. The techniques required for successful hillside farming are those that capture water, minimize runoff and erosion, and help build soil fertility. Some techniques are very simple, such as plowing along the contour and leaving vegetative strips between planting. Some are more complex and expensive, and may require engineering, such as building bench terraces, correcting gullies, and building ponds and dams.

The most elegant techniques and probably the most satisfactory are associated with the use of multiple purpose legumes in systems of alley cropping. Trees along the contours are used to gradually develop terraces and meanwhile enrich soil by capturing nitrogen and bringing up deeply buried nutrients, making them available in foliage, used as fertilizer. In addition, such trees may furnish firewood, feed, or occasionally food.

The crops for hillsides should be those with very deep roots or that can take advantage of short times of availability of water.

Use of trees. Trees will often be the most useful crop plants in arid regions, for with deep roots they can make maximum use of water. Trees will need special protection when they are planted, including irrigation in time of need. A good tree crop ought to fill many purposes.

Residual moisture. In some soils in arid regions with short rainy seasons, crops are planted near the end of the rainy season and even after rains have ceased in order to take advantage of moisture stored in the soil. Tepary beans are produced using this principle. Melons are often used as such crops in Central America.

Alternate years. A common practice in arid regions is to plant only every other year. During the year when the ground is left fallow, weeds, which use up the water in the soil, are controlled. This type of planting is suitable only for soils with a large capacity to store water. This will be evident when the crops or weeds on a soil remain green for a long period after rains have ceased.

Feeding of animals. Crop residues, both harvested and those left in the fields, may be used as feed during dry seasons. Animals such as cattle, goats, sheep, hogs, chickens, and ducks clean up the field and can help eliminate weed seeds, and, of course, they also leave their manure.

CROP PLANTS FOR TROPICAL ARID REGIONS

Crop plants for arid regions are those that survive and produce in spite of aridity. However, in almost all of these crops, seeds must be germinated or cuttings must be rooted under conditions of almost normal water availability. Therefore, when one speaks of tolerance of dry conditions one is talking mostly about the drought tolerance of the growing or mature plant. In the following tables, plants that are useful in arid regions are considered. These plants vary in ability to tolerate aridity and in yields under arid conditions. Choosing the right crops for arid regions might involve considerable experimentation in a particular region, and, in fact, the development of suitable production systems might require years. This should come as no surprise. Native systems, as crude as they may appear, usually represent the accumulated wisdom of centuries of experimentation. If this is so, how can one hope to make an improvement? The answer is often in the introduction of species or varieties unknown in the region. In other cases it is the introduction of technologies developed in other regions (see page 185 for resources).

TABLE 1. FOOD PLANTS FOR DRY REGIONS OF THE TROPICS

Degree of Tolerance (0=none to 3=high)

CEREAL GRAINS

Scientific name	Common name	
Zea mays	Corn	1

Zea mays	Corn	1
Sorghum bicolor	Sorghum	1.5
Pennisetum americanum	Pearl Millet	2.5

Degree of Tolerance (0=none to 3=high)

GRAIN LEGUMES

Phaseolus vulgaris	Common Bean	1
Vigna unguiculata	Cowpea	1.5
Cajanus cajan	Pigeon Pea	2
Dolichos lablab	Lablab Bean	2
Vigna radiata	Mung Bean	2
Phaseolus acutifolius	Tepary Bean	2.5
Vigna aconitifolia	Mat Bean	2.5
Tylosema esculentum	Marama Bean	3

Degree of Tolerance (0=none to 3=high)

LEAFY VEGETABLES

Symphytum officinale	Comfrey	1
Manihot esculenta	Cassava	1
Cnidoscolus chayamansa	Chaya	2
Moringa oleifera	Moringa	2
Leucaena leucocephala	Leucaena	2.5

Degree of Tolerance (0=none to 3=high)

ROOT CROPS

Dioscorea rotundata	White Yam	1
Manihot esculenta	Cassava	2
Sphenostylis stenocarpa	African Yam Bean	2

Degree of Tolerance (0=none to 3=high)

VEGETABLES

Citrullus lanatus	Watermelon	1
Cucurbita mixta	Mixta Squash	1.5

Cucurbita mixta	Mixta Squash	1.5
Cynara scolymus	Globe Artichoke	1
Abelmoschus esculentus	Okra	1.5

Degree of Tolerance (0=none to 3=high)

FRUIT TREES

Carica papaya	Papaya	1
Pouteria campechiana	Canistel	1
Psidium guajava	Guava	1
Spondias cytherea	Golden Apple	1
Olea europaea	Olive	1.5
Tamarindus indica	Tamarind	1.5
Zizyphus jujuba	Jujube	1.5
Carissa carandus	Karanda	2
Dovyalis abyssinica	Dove Plum	2
Punica granatum	Pomegranate	2
Anacardium occidentale	Cashew	2.5

Opuntia spp.	Prickly Pear Cactus	2.5
Phoenix dactylifera	Date	3

Degree of Tolerance (0=none to 3=high)

OIL PLANTS

Pentaclethra macrophylla	Owala Oil	1
Helianthus annuus	Sunflower	1
Butyrospermum paradoxum	Shea Butter	2

Degree of Tolerance (0=none to 3=high)

MISCELLANEOUS

Catha edulis	Khat	2

TABLE 2. NON-FOOD PLANTS FOR ARID REGIONS

Degree of Tolerance (0=none to 3=high)

FEED LEGUMES

Scientific Name	Common Name	
Gliricidia sepium	Mother of Cacao	1.5
Ceratonia siliqua	St. John's Bread	1.5
Prosopis spp.	Mesquite	2
Leucaena leucocephala	Leucaena	2.5
Acacia albida	Apple Ring Acacia	2.5
Acacia tortilis	Umbrella thorn	2.5
Parkinsonia aculeata	Jerusalem Thorn	3

Degree of Tolerance (0=none to 3=high)

FEED GRASSES

Cynodon dactylon	Bermuda Grass	1
Digitaria decumbens	Pangola Grass	1
Sorghum sudanense	Sudan	1

Degree of Tolerance (0=none to 3=high)

FIBER PLANTS

Gossypium barbadense	Sea Island Cotton	1
Agave fourcroydes	Henequen	2
Agave sisalana	Sisal	2.5

Degree of Tolerance (0=none to 3=high)

TIMBER PLANTS

Swietenia mahogoni	Mahogany	1
Acacia tortilis	Umbrella Thorn	2.5

Degree of Tolerance (0=none to 3=high)

PLANTS FOR ALLEY CROPPING

Gliricidia sepium	Mother of Cacao	1.5
Cajanus cajan	Pigeon Pea	2

Leucaena leucocephala	Leucaena	2.5

Degree of Tolerance (0=none to 3=high)

GROUND COVER

Dolichos lablab	Lablab Bean	2
Canavalia ensiformis	Jack Bean	1.5

Degree of Tolerance (0=none to 3=high)

WINDBREAK

Casuarina spp.	Casuarina	2
Eucalyptus spp.	Eucalyptus	1.5
Tamarisk spp.	Tamarisk	2.5

Degree of Tolerance (0=none to 3=high)

LIVING FENCE

Gliricidia sepium	Mother of Cacao	1.5
Bursera simaruba	Gumbo Limbo	1.5
Acacia nilotica	Babul Acacia	2.5
Euphorbia tirucali	Pencil Euphorbia	3

ANIMALS FOR DRY REGIONS OF THE TROPICS

Why Animals? In dry regions of the tropics where agriculture is always difficult, animals are frequently more capable of utilizing the often abundant plants that are available, and many times can be fed with crop residues. While some feed crops are given in Table 2, the most important feeds in many regions will be those which grow by themselves, naturally and untended. Sometimes improvement of this natural fodder by fertilizing, watering, or selected weeding may be the best solution to increasing the yield of animal feed. In addition, appropriate care of animals is necessary, and even poor herdsmen are often very skilled in raising animals.

Animals on the farm can be used for a wide variety of purposes. In addition to excellent food in the form of eggs, milk and meat, animals serve as beasts of burden, and can be trained to handle difficult jobs on the farm. The dung is a useful resource for crop production but is also used in plastering walls and floors, and when dry, as fuel. Animal wool, hair, or fur can be used in bedding and clothing.

Principal Animals and Their Characteristics. Cattle. In many arid regions the production of cattle might be the best way to make use of land. Cattle feed principally on grasses, but also benefit from legumes. They are much less apt to graze or browse on shrubs than goats. They are very adept at finding something useful to eat on grasslands, even during the dry season. Cattle may be used for milk, for meat, for farm labor, and for their hides and other by-products. There are many breeds of cattle, often used for a single purpose, or at times serving for two or more main purposes, and some of these will be much more adapted to a given situation than others. Choosing the appropriate breed or strain of cattle will always be important.

The carrying capacity of land, the number of cattle (or, other animals that can be raised on it), will vary widely, and can determine the success or failure of a given venture. Cattle may graze in open range or fenced pastures, but in either case, rotation is necessary in order to not destroy the future potential of the grazing area. Improvement of the grazing area can be achieved by the introduction of new grasses or legumes, by fertilization, occasionally by fire (a risky process), by killing poisonous plants, and by eliminating brush and some trees. Some breeds will gain more on a given pasture than others.

Since cattle raising is a capital-intensive effort (even the cattle represent considerable capital), a great deal of investigation and local knowledge is desirable before embarking on such an enterprise. On the other hand, raising the family cow is possible almost everywhere and can be the foundation of success on the small farm.

Goats. Goats may be produced for about the same purposes as cattle, and their smaller size makes them suitable for many situations. They are often grazed on open range in arid regions. They are browsers (nibble at a variety of plants), and sometimes are better adapted to production of useful meat than cattle, especially in heavy shrubland. While goats may be raised for milk, the really fine milk varieties are not well adapted in the tropics.

Sheep. In addition to the wool-bearing sheep of the temperate zone, there exist hair sheep which are much better adapted to the tropics. In addition to their value in producing meat, such sheep are often used to control weeds in orchards, and thus constitute a profit-producing biological control.

Burros. The small donkey of the drylands of the world is supremely adapted to living off the browse and meager feed often available, and for its size is surprisingly strong and a magnificent beast of burden. Not to be laughed at, the burro can easily be adapted to useful roles on the farm, including basic transportation and pulling carts.

Camels. This species is best adapted to very dry areas where agriculture is very limited.

The choice of animals for the farm in the arid tropics, and the techniques used to raise such animals are very important, and vary considerably from one region to another.

Feed Crops. After adaptation, no element in the production of animals is more important than feed. Farmers may be quite conscious of acceptable treatments in care and breeding of their animals. They may not be aware of the progress that could be made by improvement of feeds, even though such advice may be available through local agricultural experiment stations, extension services, or the department of agriculture. A first step in improving animal production should be to learn how farmers are feeding animals, and the second step is to learn what feeding practices are recommended. A third possible step, much more difficult, is to learn the feeding practices in areas of similar soils and climates.

A major problem in the production of animals is what to feed them during the dry season. An efficient production system includes solving this problem in advance. Some of the potential solutions include: dry season irrigation of pastures; restricted grazing of pastures during wet seasons so that feed will remain for the dry season; harvest and storage of wet feed as silage; harvest and storage of dry feed as hay, or as seed, in the case of grain crops; cultivation of feed crops adapted to arid zones; and migration to more productive areas.

One of the most useful possibilities for increasing dry season feed is the use of crop residues. The value of such residues as feed varies, and sometimes other substances are added to enhance palatability or nutritive value. In a well-managed agricultural enterprise of any kind, it will be useful to look for such potential uses of residues.

Another solution to the problem of dry season feed shortage is to reduce the size of the herd as the dry season approaches. The frequent practice of letting animals go hungry cannot be recommended as good husbandry.

USEFUL PUBLICATIONS AND ADDITIONAL RESOURCES (prepared by ECHO staff).

Agroforestry Technology Information Kit by The International Institute of Rural Reconstruction (475 Riverside Drive, Room 1035, New York, NY 10115, USA) cost: $27. Kits are also available as well from their headquarters in the Philippines: IIRR, Silang, Cavite 4118, PHILIPPINES.

Agroforestry in Dryland Africa by Rockeleau, D., Weber, F. and Field-Juma, A. 1988, ICRAF (International Centre for Research in Agroforestry, P.O. Box 30677, Nairobi, KENYA). 311 pp. cost: $31.00.

Crops of the Drier Regions of the Tropics by D. Gibbon and A. Pain, available from Longman Scientific & Technical, Longman Group UK Ltd., Longman House, Burnt Mill, Harlow, Essex CM20 2JE, UK.

ECHO's Technical Note on Dry Farming by Randy Creswell, cost $3.00.

Haloph: A Data Base of Salt-Tolerant Plants of the World by James A. Aronson, 1989, Office of Arid Lands Studies (The University of Arizona, 845 North Park Ave., Tucson, AZ 85719, USA).

Lost Crops of Africa, Volume 1: Grains (NAS), limited supply available from ECHO. More Water for Arid Lands: Promising Technologies and Research Opportunities and Saline Agriculture: Salt-Tolerant Plants for Developing Countries, both by National Academy of Science (National Research Council, Office of International Affairs, 2101 Constitution Avenue, Washington, D.C. 20418, USA). Order from AgAccess, P.O. Box 2008, Davis, CA 95617, USA; phone 916/756-7177.

The Challenge of the Negev by Dr. Evenari (Ben-Gurion University of the Negev, P.O. Box 1025, Beer-Sheva 84110 ISRAEL).

Food from Dryland Gardens by David A. Cleveland and Daniela Soleri (Center for People, Food and Environment, 344 South Third Ave., Tucson, AZ 85701, USA). A comprehensive handbook.

Practical Guide to Dryland Farming Series: Introduction to Soil and Water

Conservation Practices; Contour Farming with Living Barriers; Integrated Farm Management; and Planting Tree Crops by World Neighbors in Indonesia (Studio Driya Media; Jl. Tubagus Ismail Raya No. 15; Bandung, West Java 40143; Indonesia) available at $4 per booklet from World Neighbors, 4127 NW 122 St., Oklahoma City, OK 73120-8869, USA; phone 405/752-9700.

Seed Sources for Arid Land Gardeners: see the chapter on Seeds and Germplasm.

Information Sources for Arid Land Gardeners: Office of Arid Land Studies (The University of Arizona, 845 North Park Ave., Tucson, AZ 85719, USA).

The Center for People, Food and Environment (344 South Third Ave., Tucson, AZ 85701, USA).

Maricopa Agricultural Center (37860 W. Smith-Enke Rd., Maricopa, AZ 85239, USA).

Int'l Crops Research Institute for the Semi-Arid Tropics (Patancheru, P.O. Andhra Pradesh 502-324, INDIA).

International Center for Agricultural Research in the Dry Areas (P.O. Box 5466, Aleppo, SYRIA).

Drought Defenders Project (Henry Doubleday Research Assn., Ryton-on-Dunsmore, Coventry, CV8 3LG, UK).

Arid Lands Information Network (174 Banbury Road, Oxford, OX2 7DZ, UK). Publish "Baobab," a networking publication for those working in arid lands. International Institute for Environment and Development (3 Endsleigh St., London, WC1H ODD, UK; phone +44 71-388-2117; fax +44 71-388-2826; e-mail iieddrylands@gn.apc.org). Publish the quarterly "HARAMATA, Bulletin of the Drylands."

SEPASAL (Survey of Economic Plants for Arid and Semiarid Lands, Centre for Economic Botany, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AE, UK; fax +44 81-332-5278). Plant information database.

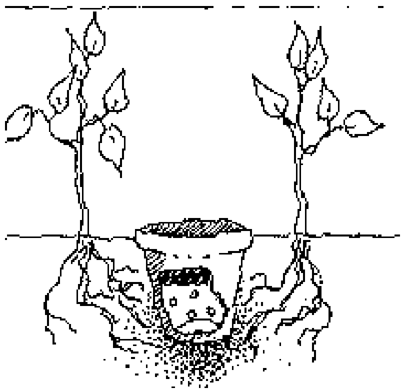
Video: Looking After our Land: Soil and Water Conservation in Dryland Africa. (Oxfam Publications, c/o BEBC, P.O. Box 1496, Parkstone, Poole, Dorset BH12 3YD, UK; phone 01202 715555; fax 01202 715556.) A two-hour tape (£14.95) and an illustrated 88-page book (£8.95); specify whether you want the English or French version and whether your video equipment uses the PAL, SECAM or NTSC system.

Dryland techniques and water resources

A TECHNICAL NOTE ON DRY FARMING by Randy Creswell in Mali, West Africa, is available from ECHO. This 18-page note gives specific technical guidelines for growing plants in arid regions. Randy defines dry farming as "the profitable production of crops, without irrigation, on land with a low average or highly variable rainfall." The document gives practical steps for increasing water absorption, reducing the loss of soil moisture, suitable cropping systems, mulching, plowing and tillage, planting, and a series of tables on requirements of drought-resistant crops. Available from ECHO for US$3 (free to development workers).

You may know of special techniques or plants for arid regions that may also help other readers. The quality of EDN is greatly increased as our readers share their best ideas with us. Please write!

PARTIALLY BURIED FLOWER POTS OR TIN CANS SAVE IN WATERING. Like many of you, we have a very long dry season at ECHO. Many plants are beyond the reach of our irrigation system. Even though we have the luxury of reaching them with a garden hose, it can still be quite a task (and waste of water) to get the soil sufficiently wet in the root zone of a fairly recent planting. Often I have had the water flowing for five minutes only to find that the soil is dry an inch below the surface. Forming a shallow basin around the tree can help, but it must be reconstructed and much of the water remains near the surface and quickly evaporates.



partially buried flower pots or tin cans save in watering

Now when we transplant a tree we bury an old flower pot with drainage holes just outside the rootball. The size is not too important; we use about a 15 cm (6 inch) diameter pot. When watering we quickly fill the pot once or twice and we are done. All the water is channeled directly into the soil near the rootball. Sometimes we throw a pinch of fertilizer into the pot.

This is a takeoff on a technique you may have read about. In some arid regions farmers grow plants next to a buried porous clay pot. That would no doubt provide a slower more controlled release of water, but it has two disadvantages. First, it sounds expensive (if such pots are even available). Secondly, the very slow release of water would encourage roots to concentrate only around the pot. The water rather quickly leaks out of the regular flower pot (no doubt some is lost to the plant when it is young) but forms a "ball" of moist soil into which a large quantity of roots can grow.

In parts of my own garden I have started using this technique for vegetables and flowers also. I place the bottom of the pot about 3 inches deep and cluster plants around it, the number and spacing depending on the size of the mature plant. A benefit I had not anticipated is that small weed seeds near the surface of the soil are less likely to germinate because the surface remains dry.

I was pleased to read in the July-September 1991 issue of Agroforestry Today that a farmer in Kenya has devised and used a very similar approach. George Nti'Gitonga "realized that the normal period for planting-during the rainy season-was not the best time to establish seedlings. There were two reasons: a labor bottleneck due to work [with other crops]... and difficulties in working the heavy clay soils when they were wet." Also he knew the rains might not come.

"So Mr. Nti'Gitonga plants his trees during the dry season, when the soil is powdery and he and his family have more time.... He buries an old tin can next to each tree seedling with a small hole punched near the bottom on the side facing the tree. The farmer fills the can with water, which runs out quickly into the dry soil. He then fills the can again and covers it with a stone (to prevent evaporation).... Using this method he needs to water his seedlings only once a week. In fact, they can survive 2-3 weeks without additional watering." Using this method, he has established 25,000 trees on his farm. Recently he won first prize in a national contest to reward farmers for outstanding contributions to rural tree planting.

Dr. Carl Campbell at the University of Florida responded to this article: "I was especially interested to read about the use of pots or cans sunken into the ground for watering plants. I have been doing that in a limited way for a long time too, and have seen and read about many cases in which the method is used. For me a useful variation is to leave the container above ground, on the surface, so it can be moved to water more than one plant. I like to use large plastic jugs with a very tiny hole when I am going to be gone for a few days and have some tender, newly planted trees."

CAPTURING WATER FROM FOG for household or agricultural use is a promising technology. It is not a new idea: African nomads and Andean people have long taken advantage of trees' natural water-catching properties by collecting morning dew or using the water trapped by forests. But now scientists around the world are working to enable more dryland communities to harvest the fog water in their regions.

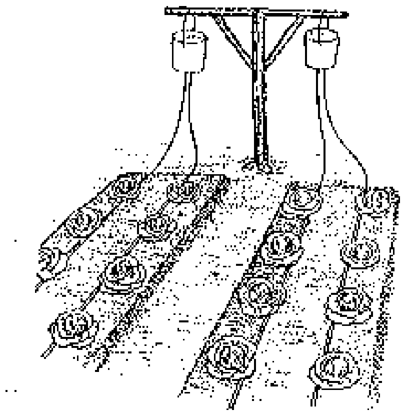
The technology is simple: polypropylene meshes are set up vertically in areas with dense fog and light winds. As the fog passes through the mesh, the suspended water droplets are caught by the net and drip down into a collection trough and are channeled into a storage tank. Water captured by the nets is of excellent quality-fog is a long-term sustainable resource much more reliable in both availability and safety than groundwater in many areas. This technology is best suited to upland areas with persistent fogs that limit visibility to 100 m or less and light winds (about 10 km/h) needed to carry the fog through the mesh. The knitted polypropylene meshes known to be effective are inexpensive (about US$0.25 per m2), durable, and available from many sources worldwide.

In 1995, three ECHO staff visited one site just north of Quito, Ecuador, in which the water-catching nets have been successfully installed. The area near the Mitad del Mundo ("Middle of the World") equatorial monument is a dry, eroded zone plagued by dust storms. Nearby is a fertile volcanic crater called Pululahua, an ecological reserve known for its unique vegetation. The people above the crater can see the near-constant fog from distant humid valleys which blows across the crater and over their dry land. A few years ago, trial fog collectors of 1 m2 were erected on the ridge above the crater (at 2830 m elevation) to catch water droplets in the fog that passes through the nets. The trial collectors harvested up to 20 liters of water a day, with a daily annual average of 12 liters. Based on these results, sixty-three 4.5 m x 6 m mesh panels were set up on the ridge and are now capturing water for the nearby arid community.

Fog collection is one of the most hopeful water-harvesting technologies for certain zones. It is not suited to every area, however, and trial nets are a wise investment if you believe fog collection has promise in your area. Some limitations include very strong winds which can damage the collectors, not enough wind, insufficiently dense fog, and inaccessible sites. A collector (two vertical posts mounted in well-packed holes and anchored with strong cables, mesh secured with cables, and a plastic collection trough) with a 50 m2 surface area could cost US$300- 500, which could cost significantly less than buying water from trucks, for example.

Dr. Robert Schemenauer of Environment Canada is a cloud physicist and one of the primary researcher-promoters of fog collection. He sent ECHO some excellent publications on site evaluation for fog harvesting, details on setting up a trial net, sources of mesh, and more. Write to ECHO for this introductory information if you see a potential for your area. Address more specific correspondence to Dr. Schemenauer at Atmospheric Environment Service, 4905 Dufferin St., Downsview, Ontario M3H 5T4 CANADA; fax: 416/739-4211. There will be a July 1998 conference on fog collection in Vancouver, BC, Canada; write Dr. Schemenauer for more details.

DRIP IRRIGATION was demonstrated at ECHO's 1995 conference by Dick Chapin and former ECHO intern Beth Adams, who taught vegetable production in Malawi. Chapin Watermatics produces "bucket kits" of gravity- run drip irrigation used in vegetable garden projects in developing countries. These kits enable people to produce vegetables with the same efficient use of water that commercial drip systems provide.



drip irrigation

The system consists of a 5-gallon bucket mounted 1 m above soil level, a filter- stopper fitted into a hole in the bottom of the bucket, two connecting tubes, and two 50-foot (15m) lines of 15-mil drip tape with outlets 12" (30cm) apart. (Buckets are not provided with the kits.) Prepare the garden beds 15 m x 1 m for two rows of plants. Lay one drip line along each side on the surface of the bed. Fill the buckets and transplant alongside the drip tapes near the holes. The buckets need to be filled twice daily with water; soluble fertilizer or manure tea can be used as needed. Mulch placed over the tape reduces surface evaporation. The kits can produce vegetables for up to 5 years if carefully maintained.

ECHO is evaluating this drip system in some of our garden beds. The plants are growing very well. We anticipate that foliar diseases, sometimes spread by overhead irrigation, should be reduced. The kits are suitable for vegetable production in our dry season. Dick Chapin offers a free demonstration kit, literature, and video for agricultural missionaries in developing countries. Further kits can be purchased for a small fee. Contact Dick Chapin at 368 N. Colorado Ave., Watertown, NY 13601, USA; phone 315/786-8120 or 788-0891; fax 315/782-1490.

WAYS OF WATER: RUN-OFF, IRRIGATION AND DRAINAGE (382 pp.) by Hugues Dupriez and Philippe De Leener is an excellent handbook on water management, full of clear diagrams and photos (both close-ups and aerial). Topics are grouped into bite- sized lessons several pages long. Section headings include water and soil, water in plants, water in the air, surface water, watering crops, irrigation methods and efficiency, and lifting water. This is a comprehensive resource, readable with well-illustrated details on every topic. VANISHING LAND AND WATER: SOIL AND WATER CONSERVATION IN DRY LANDS (117 pp.) by J.L. Chleq and H. Dupriez is another book in the same series. This one covers erosion causes and control, wells, and water lifting. It is also illustrated in the same style; see 'page' at right. Available in French and English. African, Caribbean, and Pacific nationals may contact CTA, Postbus 380, 6700 AJ Wageningen, NETHERLANDS; also available (£13.99 and £5.95, respectively) from IT Publications; see below under "Waterlines."

LOOKING AFTER OUR LAND: SOIL AND WATER CONSERVATION IN DRYLAND AFRICA. Oxfam and the arid lands unit of the International Institute for Environment and Development have teamed up to make a video and book duo that is a welcome addition to our video library. The book contains many excellent pictures and illustrations, and the tape is informative with a lot of content at a modest price.

Oxfam writes, "The book and video have been produced expressly for development workers in arid and semi-arid Africa, but will also be of general interest to a wider audience... It is suitable for use in workshops and discussion groups and the material is reinforced by the book. [Ed: I would go further than that. The book gives a lot of technical details that either are not in the video or were not obvious, but which you are going to need when time comes to try the methods.]

"The video and book are about the main lessons to be learned from new approaches to soil and water conservation in sub-Saharan Africa. Six case studies, two each from Burkina Faso, Kenya and Mali, show how, in the wake of many failures, some success has been achieved in projects where the participation of local people has been recognized as the crucial issue." The authors/producers deal with both the social and technical side of the work.

The 2-hour tape costs £14.95 and the very well illustrated 88-page book £8.95. Order from Oxfam Publications, c/o BEBC, PO Box 1496, Parkstone, Poole, Dorset BH12 3YD, UK; phone 01202 715555; fax 01202 715556. BE SURE TO SPECIFY whether you want the English or French version AND whether your video equipment uses the PAL, SECAM or NTSC system. Add for postage: 20% in the UK, 35% Far East and

25% elsewhere. (The book only is available for US$14.95 from Humanities Press, 165 First Ave., Atlantic Highlands, NJ 07716, USA; phone 908/872-1441.)

PRACTICAL GUIDE TO DRYLAND FARMING SERIES. Lucy Fisher with World Neighbors in Indonesia sent us a copy of this wonderful set. I am excited about it for several reasons. It is unbelievably well illustrated with detailed drawings. It deals with subjects that are of great interest to many development workers. It describes in detail several of the techniques that have been the basis for some dramatically effective projects by many groups in various countries. Finally, at $4 per booklet, it is a good price.

Titles of the four units are: Introduction to soil and water conservation practices, Contour farming with living barriers, Integrated farm management, and Planting tree crops.

Lucy wrote, "We have been reading EDN for several years, and have found much that has been relevant to the agricultural programs we assist in Southeast Asia. Perhaps some of your readers would be interested in the agricultural extension booklets used in the programs we support here in Indonesia and the Philippines." Originally published in Indonesian, they are now available in English.

"While the methodologies discussed are specifically applicable to the conditions found in the semi-arid regions of SE Indonesia, many are relevant throughout the uplands in the tropics.

"The first book, 44 pages, discusses the basic principles of soil and water conservation on sloping land. Design, construction, use and maintenance of contour-based systems (hedgerows, rock barriers and bench terraces) to reduce erosion and increase rain water absorption are described.

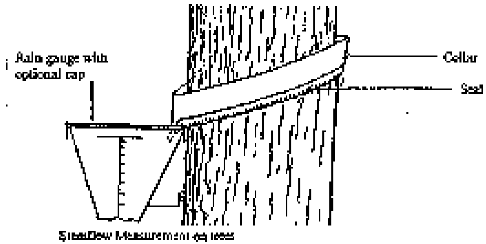
"The second book, 40 pages, considers the reasons for contour farming with terraces as well as methodology. Details include finding the contour lines of the slope, dike/ditch preparation, hedgerow species selection and planting, maintenance of terraces, and alternative uses for the living barriers (which include a variety of leguminous shrubs and grasses).

"The third book, 36 pages, covers integration and diversification of upland farming activities to reduce risk and increase farm productivity. Soil and water conservation is promoted as the basis for integrated farming. Topics include soil fertility, cropping practices and patterns, livestock, tree crops, cover crops, wood production and environmental conservation.

"The fourth book, 38 pages, covers integration of tree crops into the farming system, uses of tree crops, propagation methods (seed, stakes, grafting, air-layering), nursery construction and maintenance, planting out/transplanting, and subsequent care of trees. It also includes a planning worksheet and tables of suggested tree species according to use."

Booklets are $4 each plus postage, English only. Order from World Neighbors, 4127 NW 122 St., Oklahoma City, OK 73120-8869, USA; phone 800/242-6387 or 405/752-9700; fax 405/752-9393. For the Bahasa Indonesian version, write to Studio Driya Media, Jl. Makmur, 16 Bandung, West Java, INDONESIA.

HANDBOOK FOR AGROHYDROLOGY (281 pp.) provides details on the practical aspects of hydrological research in agriculture. If you are evaluating the need for runoff water or rainwater collection and soil erosion control, learning about soil moisture, designing a water harvesting plan, or processing water statistics, this book will be extremely useful to you. The book is written for agricultural staff without hydrological expertise who work in developing countries, where proper use of limited resources is critical but extensive data is usually not available. Some mathematical/chemical background is necessary in using this book, although the text is clear enough to be very informative for even the beginner in this field.



water harvesting from a tree

Agrohydrology uses an understanding of water processes to increase crop production, largely by optimizing soil moisture. The three main sections of the book are: Runoff and its measurement, Water harvesting and field structures, and Data analysis. The equipment used in data collection is also covered in depth.

The chapter "Water Harvesting and Field Structures" covers three scales of systems. Micro systems concentrate water over an area of less than 1 meter, such as tied ridges and furrows (construction details and examples from Botswana and Zimbabwe). Meso techniques gather runoff from within a few meters, such as zai holes, contour bunds or ridges, diamond-shaped basins, and strip tillage. Macro systems, including broad flat catchments over large areas, are described with details on their feasibility and design.

The book is available for £30 including surface mail from Publications Distribution Office, Natural Resources Institute, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK. No charge is made for single copies sent to governmental, educational, research, and non-profit organizations in countries eligible for British Government Aid. Use your official title and write on letterhead when requesting a free copy.

"WATERLINES" FROM IT PUBLICATIONS is "the world's only magazine devoted entirely to low-cost water supply and sanitation. It is written for professionals-administrators or engineers, project managers or policymakers, trainers or workers in the field." It is quarterly, and the cost for individuals is £15/$28 per year (£21/$40 airmail). ECHO has not seen this magazine, but coming from IT, we expect that it would be very useful. Write to subscribe and request a catalog: IT Publications, 103-105 Southampton Row, London WC1B 4HH, UK; phone +44 171 436 9761; fax +44 171 436 2013. The IT catalog lists over 60 of the best books on water conservation, supply, sanitation, scarcity, irrigation, pumps, filtration, and harvesting.

THE ARID LANDS INFORMATION NETWORK (ALIN) in Senegal is an organization primarily for field workers to share their practical knowledge of development work in arid and semi-arid areas of Africa. They offer networking opportunities with other people doing similar work in your area, helpful booklets on development topics, and the fine publication Baobob. Baobob is written three times a year (English and French) by ALIN members who exchange ideas and experiences in community development in Africa. Members receive all ALIN publications free of charge. Membership is free to all individuals working in dryland areas of Africa; paid subscriptions are available for other organizations and individuals. Write ALIN at Casier Postal 3, Dakar-Fann, SENEGAL; phone 221 25 18 08; fax 221 25 45 21. Direct all subscription enquiries for Baobob to Sally Lane, ALIN, 274 Banbury Road, Oxford OX2 7DZ, UK; tel 44 865 312402; fax 44 865 312600.

TRAINING IN INFRASTRUCTURE FOR DEVELOPING COUNTRIES. Water, Engineering and Development Centre (WEDC) sent us information about their unique courses. WEDC is a unit within Loughborough University of Technology devoted to training, research and consulting related to the planning, provision, operation and maintenance of water supplies, sanitation and physical infrastructure in developing countries. They offer an interesting variety of short courses (3-12 weeks) and Masters-level courses.

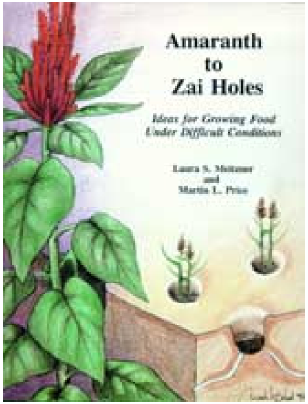
Examples of 12-week diploma programs include "Irrigation and Water Resources," "Community Technology for Rural Development," "Groundwater Development," Infrastructure for Low-income Urban Housing," "Management of Municipal Services," Project Preparation for Environmental Engineering," "Solid Waste and Environmental Management," "Urban Water Supply," "Wastewater and Irrigation," et. al. Shorter courses are offered on related topics. Special individual study programs, in-country training, and Masters or Doctorate research is also possible.

Twelve-month MSc courses which focus on developing countries include "Water and Waste Engineering," "Water and Environmental

Management," "Urban Engineering," "Urban Water Supply," "Technology and Management for Rural Development," and "Planning and Management of Urban Services." These programs cost £9,250 in 1996-97 for continuous study.

Request fliers giving details and costs for any of the above from the Admissions Secretary, WEDC, Loughborough University of Technology, Leicestershire, LE11 3TU, ENGLAND; phone 0(44)1509 222885; fax 0(44)1509 211079; e-mail wedc@lut.ac.uk.

THE URBAN AGRICULTURE NETWORK has been active since 1993, and now has 3000 members in 40 (primarily developing) countries.



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

8: Plant protection and pest control

Protecting plants from pests, diseases, and predators is part of any agricultural system. Start by promoting healthy soil which grows strong, resistant plants, and learn about timing and conditions of disease and pest outbreaks. Attention to cultural controls, such as field preparation and correct time of sowing and harvest, can prevent disease or avoid insect outbreaks. Diversity of crops provides security from major losses.

Commercial pesticides may be too costly or risky without controlled application or protective equipment, and disruptive of beneficial insects.

Close and frequent observations of plant health and other organisms in the field are instructive for the newcomer to tropical agriculture. Learn to distinguish beneficial and harmful insects. Discuss your findings with farmers, and experiment with locally-used control strategies to determine effectiveness. The best control is to prevent an outbreak if possible, and to use treatments of minimal toxicity when necessary. This chapter collects some of the ideas shared with ECHO through the years on prevention and control of disease, insect and small pests, and larger animals which damage crops in the field. ECHO is always looking for more ideas on these subjects from the field; send us what you learn for future networking through EDN.

Resources

TWO EXCEPTIONAL BOOKS ON NATURAL PEST CONTROL. Most of you have encountered traditional crop protection strategies or sprays made from local plants to control pest outbreaks in the field or in stored products. There are as many practices of insect control as there are villages, and it is extremely difficult to gather this valuable information. These books compile clear, practical details on prevention and remedies for plant protection. Natural Crop Protection Based on Local Farm Resources in the Tropics and Subtropics by Gaby Stoll (188 pp.) offers many preventive and curative measures used effectively by farmers around the world. Primary pests in field or storage of major crops are described with host plants, distribution, life cycle, damage pattern, and various control measures. The methods of crop and storage protection include thorough information on over 27 insecticidal plant groups and brief mention of other substances and techniques. Available in English, French, German, Spanish, Thai, and Singhalese. Single copies are US$29 plus postage from: Margraf Verlag, Postfach 105, 97985 Weikersheim, GERMANY. You may also order for 35 SFr. (about US$27) from the publisher, AGRECOL, c/o Oekozentrum, CH-4438 Langenbruck, SWITZERLAND; phone 062/601420; fax 062/601640. (AGRECOL is a networking and information center for sustainable agriculture in the developing world. Their publications are excellent and usually available in several languages; ask for the catalog. The (Spanish or French) resource guides are bibliographies to useful literature and organizations.)

Natural Pest and Disease Control by Henry Elwell and Anita Maas (128 pp.; fine illustrations by Rose Elwell, see right) is a comprehensive collection of strategies used by farmers in southern and central Africa. This kind of resource is hard to find. The book includes guidelines for prevention, many remedies for common problems, and plant names in five regional languages. The information on action, targets, detailed preparation and application, other uses, and warnings for over 66 cultivated and wild plants in insecticidal/repellent sprays is hard to find in other sources. One chapter on "miscellaneous substances and methods" gives details on using ash, milk, noise, baking soda, traps, etc. to control pests and disease. Order for US$6 within Africa/$8 elsewhere from the Natural Farming Network-Zimbabwe, P.O. Box CY 301, Causeway, Harare, ZIMBABWE; phone 726538/731541; fax 263-4-723056. (See the Natural Farming Network article in the chapter on Farming Systems to order from other African countries.)

"BIOLOGICAL CONTROL OF ARTHROPOD PESTS AND WEEDS" is run each May at Silwood Park, UK. This is a "practical 'hands-on' training course on how to use natural enemies as biological control agents in tropical and temperate agriculture, forestry, and biodiversity conservation. We welcome participants from crop protection research and extension services, universities and rural development NGOs." The course studies predators, parasites, and diseases which control insect pests; insects and fungal diseases as weed controls; and the practical aspects of evaluating, rearing, and releasing the natural enemies. Cost is £3450 (about US$5200), including fees, accommodation, and food. No scholarships are available from IIBC. Contact Stephanie Williamson, International Institute of Biological Control (IIBC), Silwood Park, Ascot, Berks, SL5 7TA, UK; phone 44 1344 872999; fax 44 1344 875007; e-mail s.williamson@CABI.org.

THE COMPENDIUM OF PLANT DISEASE SERIES is valuable in identifying crop diseases. Bacterial and fungal diseases of plants are notoriously difficult to diagnose in the field. This series offers excellent descriptions of symptoms and clear photographs of affected plants so you know what problem to address. Each soft cover book covers one or more specific crops, such as sweet potato, bean, corn, barley, cotton, potato, citrus, peanut, onion and garlic, alfalfa, and other fruits, grains, and ornamental species. Each has a comprehensive description of the diseases (some also include insect and nematode pests) of that crop, including the symptoms, causes and pathogens, disease cycle, and specific options for control. The controls presented include preventive steps, cultural techniques, optimal timing of chemical application, and effects on other crops and subsequent seasons. There is also a section on nutritional deficiencies and environmental stresses on the plants, and a very complete, descriptive glossary. High-quality color plates illustrate the problems discussed in the text; some are distinctive enough to use in diagnosis.

The series is available from the American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121- 2097; phone 612/454-7250; fax 612/454-0766. The books are 50-200 pages long, and cost $30 US/$37 overseas. With that price, most people won't be able to purchase very many in the series. You may want to concentrate on those food or market/export crops which are nutritional or economic staples in the region, particularly where production seems limited by unidentified disease problems.

INSECTS IN YOUR GARDEN IN HAITIAN CREOLE. Ed Russell wrote this 117-page book in Creole called Ensk Nan Jaden Nou (Insects in Your Garden) while working with the Baptist Mission. "This book grew out of my own lack of knowledge about insect pests. I would buy pesticides that came in a plain brown bag or a used food oil can. So I had no idea how to use them properly. Talking with others, I found that there is a great abuse of pesticides in Haiti. ...The book has its roots in a brief agriculture course I was teaching at the request of a local cooperative.

"The book is divided into 5 chapters. Chapter 1: insect life histories and the identification of some common beneficial and pest insects; Chapter 2: pesticides, their dangers, proper use, and how to make home-made pesticides; Chapter 3: first aid information for pesticide poisoning; Chapter 4: a table of Latin, Creole, English and French names for the insects and botanical pesticide sources discussed in the book; Chapter 5: a table of various crops, common pests that attack them, and pesticide treatments that can be used.

"The book is neither complete nor perfect, since I do not profess to be an expert on insect matters." Ed told us that it is weak in two areas. 1. Geographic coverage. He is most familiar with problems in the Cul-de-Sac and Fort Jacque area. 2. It lacks information about some pesticides because many insecticides sold in Haiti are not sold in the U.S. He also said he did not discuss cultural methods of control, such as floating row covers, that he believed were out of reach of peasant farmers. The book is written for people doing extension work, not peasant farmers themselves.

The Baptist Mission is printing the book on a laser printer as needed and selling it in the Mountain Maid store at the mission. I think every development worker in Haiti knows where the mission is located. The cost is $7/copy, including postage. The address if ordering from outside of Haiti is Mountain Maid, Baptist Haiti Mission, Box 15650, West Palm Beach, FL 33416. Ed says, "Since I am no longer working in Haiti, other interested people may want to work on future revisions." This could easily be done because of the print-as-needed approach. If anyone wishes to do this in the future, contact Wally Turnbull at the Baptist Mission.

RODALE INSTITUTE is well-known in the United States as the publisher of the popular home gardening magazine Organic Gardening. Rodale has many good publications on natural pest control, mostly oriented for temperate regions. Ask for titles and availability from Rodale Press, 33 E. Minor St., Emmaus, PA 18098, USA.

PLANT PROTECTION IMPROVEMENT PROGRAM (PPIP) FOR EAST AND SOUTHERN AFRICA. Johan Morner, the PPIP Manager, writes that "PPIP is striving to increase its contacts with non-governmental organizations" which work in certain countries of east and southern Africa. If you work in that region and are involved in any of the activities listed below, you may be able to obtain financial and/or technical support from PPIP. It is funded by Swedish foreign aid.

"Examples of the types of activities that might qualify for support are (1) training courses on new pest control methods, (2) pest surveys and yield loss assessment in small-scale farming, (3) research into new and appropriate pest control-indigenous methods, natural pesticides, cultural practices, (4) development of extension materials and methods on appropriate pest control practices and the safe use of pesticides." For further information, contact the PPIP Coordination Unit, Swedish University of Agricultural Sciences, PO Box 7044, S-75007 Uppsala, SWEDEN; phone 46 18 672516; fax 46 18 672890; e-mail johan.morner@entom.slu.se.

Plant protection treatments

USE STP TO MAKE "YELLOW STICKY TRAPS." Yellow sticky traps are used in greenhouses and elsewhere to monitor and even reduce populations of certain insects. Because many insects are especially attracted to yellow objects, they will settle onto a yellow card. If a transparent sticky substance is on the card, they will be trapped. It is easy to use even in remote locations, if you can find an adhesive.

HortIdeas reports that Agriculture Canada researchers have successfully used STP oil treatment. STP traps caught about as many insects as "Stickem," a commercially available coating for sticky traps. I do not know how many countries have STP or a similar product, but there is no town in the United States too small to have this famous additive for motor oil.

They found that STP can be uniformly applied with a paint brush to cardboard traps outdoors (4x11 inch cardboard painted on both sides with two coats of bright yellow alkyl semi-gloss paint, which made the cards waterproof). The STP does not cloud up when damp, it allows easy repositioning of trapped insects for identification, it does not drip and make a mess and it rarely traps large insects. A drawback is that traps must be re-coated after a heavy rain.

MORE ON INSECT TRAPS. For many growing papaya in the Americas, the papaya fruit fly, Toxotrypana curvicauda is a major pest. These insects, resembling a wasp in appearance, use their long ovipositor to lay eggs inside the seed cavity of the fruit. Larvae feed on the seeds, burrow out of the fruit, drop to the ground, and pupate in the soil.

Dr. Hal Reed recently sent us an article discussing the use of a simple trapping system for this pest. This basically consisted of a sticky-coated fruit mimic (12.7 cm diameter green sphere), coated with a controlled release formulation of a synthetic sex pheromone. In field tests, up to 10 female papaya fruit flies were caught per trap per week. Dr. Reed mentioned that a co-worker of his recently returning from Costa Rica reported very good success with lower pheromone dosages and believes it will prove to be a good survey tool and control method.

The pheromone is not commercially available yet, but a few researchers in Costa Rica and Florida are in the developing stages of making it so (in 1996). In the meantime, Dr. Reed suggests that the spheres alone would catch some flies (3 per week in the report) and afford limited fruit protection. He said that the spherical shape, 12.7 cm size and green color are key. "Perhaps one could use green balloons covered with tree sap." We will be very interested in hearing from any readers who try this approach.

We were referred to Rex Renfro, a farmer and integrated pest management consultant in Florida's tropical fruit region, who has first-hand experience with the method. In fact, he was involved in the initial USDA work. Rex does not believe it has commercial potential here because the "stickum traps" had to be removed and cleaned every ten days. "The green sphere would become black with insect bodies." Also the papaya fruit flies seemed to be repelled by the smell of the trapped insects. The cost of labor is prohibitive here, but this might not be a limiting factor in other countries. Because of the cost problem, research will probably be directed toward non- sticky traps with pheromone attractant and insecticide.

Does it work? Like a true scientist, Rex was hesitant because he did not have enough data to do a statistical analysis. "A negative result [i.e. lack of fly damage] is hard to prove without a detailed experiment, and we lacked funding for that." What he observed, though, was that they would have a fruit fly problem, would put up the traps, and the problem would disappear. After removing the traps the problem arose again and again disappeared when the traps were put up. He cannot rule out the possibility that this occurred by chance.

Rex added that those who spray their fields should first carefully note the time of day when flies are seen in the field. They normally live in more dense vegetation and travel to the papaya field at a certain time each day. In Florida that is mid-afternoon; in Costa Rica it is in the morning.

How many traps are enough? Rex put one on each tree on the outer row. The flies do not migrate very far into a papaya field, except when their population is unusually high, so the outer perimeter is sufficient. To attach them he simply pushed a welding rod into the plastic sphere, then pushed the other end right into the trunk of the tree. It did not seem to hurt the tree.

Other tips on controlling the pest: Because young larva need seeds as a food source, use seedless varieties or those with thicker walled fruits (the ovipositor is just so long). It is very important to remove and bury (over 6" deep) all fallen infected fruit. At ECHO we had some trees that bore poor quality fruit, so we left it on the ground. Soon we had so many flies that every single fruit on the farm was filled with larvae.

HOW CAN I GROW LADY BIRD BEETLES (COCCINELLA SPP.) IN CAPTIVITY? Harold Watson in the Philippines noticed that lady bird beetles were eating the plant lice that have done so much damage recently to leucaena trees in that country. He asked how he could grow them in quantity to release into special problem areas.

We visited Dennis Warkenten at the Yoder Brothers nursery near ECHO, one of the largest plant nurseries in the USA. Dennis is involved in both research and technical application of pest control operations, including biological control whenever possible. The answer was surprising.

It is true that these beetles are sold commercially in the States. However, to their knowledge, they were not raised in captivity. There are certain places in the mountains near our west coast where huge populations of the beetles come to rest during the winter. They are scooped up by the shovelful while they are dormant. When eventually warmed up, they resume activity. They mentioned that it is really not an effective approach for an individual to bring lady bird beetles into his garden because they are "programmed" to disperse when they resume activity (they were all clumped together before), so the first thing they do is leave the garden. Dennis also checked a reference for diets used in mass-rearing insects and found no reference to lady bird beetles.

A few years later, Wayne Niles, now a missionary in Haiti, visited ECHO. He had just done a laboratory project in a biological control course at the University of Florida in which he mass-produced ladybugs! We asked him to put his experience in writing for members of the ECHO network who might face this need. His comments follow:

"Raising insect enemies of harmful insects is fairly easy once you get a knack for it. In a developing country an enterprising student or villager might be taught to rear such insects as a means of livelihood, selling the insects as pest control. You need suitable containers, a food supply, and a few minutes each day for sanitation and feeding. Large numbers of natural enemies are not necessary if you can pre-inoculate your plants before the pests build up. The juvenile stages are voracious and render the best control because they do not fly away. Adults leave eggs and move on.

"A reasonable strategy would be to maintain several dozen females on artificial media in captivity and to regularly transport the eggs they lay (on leaves, for example) out to the field near sites of potential pest infestation. This augmentation of the natural ladybug population is necessary because they require 2-3 weeks per generation and would build up more slowly than aphids or psyllids.

"A word of caution, however. Be sure the ladybugs you are rearing will devour your pest. I am amazed by the diversity of ladybug species and their specificity of diet. Collect and rear only those adults that you are absolutely certain are eating your pest (not the honeydew they produce or the mold growing on the honeydew)."

The adult ladybug beetles were collected from an aphid-infested field, then were maintained in 9 cm plastic petri dishes. The female beetles were fed all the aphids that they could eat. The aphids were collected by holding an infested plant over a stiff piece of paper and beating the plant. They could be kept for up to two weeks in a tightly capped plastic bottle at 4 C. The mean daily aphid consumption by adults was 36 and mean daily egg production was 25. Larvae ate an average of 190 aphids over a 19-day period before reaching adulthood.

He enclosed a photocopy of a few paragraphs from an article by Li concerning the mass rearing of ladybugs on artificial media in China. If you do not always have a source of aphids and want to see this article, drop us a note. "I suspect adequate results can be obtained without the hormones and other exotic materials in the Chinese recipes. One can always throw a few aphids into the artificial media to supply whatever is lacking." One example was the ladybug Cryptolaemus montrouzieri, which is used to control mealybugs. It can be mass produced in the laboratory using mealybugs (grown on pumpkin or buds of potato) as food, but adults can be reared with a semi-artificial diet consisting of powdered milk, honey, yeast, a little royal jelly and dry mealybugs. Another ladybug diet contained 5 g pig liver, 0.5 g brewer's yeast, 1 g honey, and 0.05 g vitamin C (plus optional preservative).

EXPERIENCES WITH THE NEEM TREE AS AN INSECTICIDE. (For an introduction to neem and information on neem seed and products, refer to Chapter 4 on Multipurpose Trees.)

The tree originated in India or Burma, but is widely grown in much of Africa. It is used widely in India for its insecticidal and medicinal properties, but primarily for firewood in Africa. There are several active compounds, concentrated primarily in the seeds. Some inhibit larval development and reduce female fertility, others act as repellents and antifeedants. These compounds are most effective against the following families: Coleoptera (beetles and their larvae), Lepidoptera (caterpillars) and Orthoptera (grasshoppers and locusts). There are some reports of control of aphids, scales and whiteflies.

Large quantities of neem are not needed for insecticidal use. For example, 2 ml of oil mixed with 1 kg of beans which are to be stored protects against pests; 25g of ground kernels or 50g of ground seeds extracted with 1 liter of water by standing overnight then filtered through tissue can be sprayed with a knapsack sprayer. For harvest and treatment of seeds, in many areas seeds are easy to collect from the ground because birds or fruit bats eat the juicy and sweet fruits and spit out the kernels. Where this does not occur, the harvested ripe fruits need to be pulped. If water is available the risk of infection by fungi can be reduced by washing the grains after collecting them.

For further processing (oil, water extracts) and the storage the kernels should be well dried by spreading these on a hard ground in the sun. To avoid molding, kernels should always be stored in a well-aerated recipient such as a jute sack. Never store them in a plastic bag. Molding can be due to aflatoxin-producing fungi, a substance which is highly toxic to human beings even in low concentrations. To prepare seeds for planting dry them carefully, if possible in the shade, because temperatures above 45oC will reduce germination. Storage for more than one month will also decrease the rate of germination. For immediate sowing kernels do not have to be dried. (The above is excerpted from a Technical Note by M. Dreyer in Togo.)

There are many active ingredients in neem, but azadirachtin is perhaps most important. It is found in both leaves and seeds. For over 25 years, Professor Ahmed Sadiq in Sudan has been working with the use of neem in pest control, and CARE has started trials in collaboration with him. The seeds have about twice the potency of leaves, but seeds are only available for 3-4 months each year, so they are working with leaves. Leaves are dried in the shade, because the ultraviolet rays from the sun will break down the active ingredient. When the leaves are dry, they are crushed to a powder in a mortar and pestle. They can then be used directly for dusting crops or as a powder in stored foods. The powder can also be mixed with water and sprayed on crops.

Most farmers like to see pests drop dead right away. Neem does not have this effect, with a few exceptions. Its main effect is as a repellent. If insects do eat the treated plant, the neem has a hormonal and growth-regulator effect. Local farmers have used it only one year. Those who treated okra with it said grasshoppers avoided treated plants.

Farmers who treated watermelon seeds with neem powder said that rats which normally eat the seeds did not eat the treated seeds. Neem is not usually thought of for rodent control, but it has a flavor which perhaps the rats did not like. (The above is abstracted from an article in the magazine Baobab, #5, 1990. They in turn learned it from "The Farming World" of BBC World Service.)

Dick Lockman in Pakistan says that they use the dried leaves for moth protection of woolen clothing in storage. A few leaves in the pockets and scattered among the items prevent moth damage. R. N. Mall in Pakistan wrote, "We learned during the Health Education Program that in some villages the seeds are crushed and the oil is being used against head lice, which is quite effective."

Don Mansfield in Mali had success using neem leaf tea to control termites (note below), but he tried another neem recipe with disappointing results. He had heard of placing a mixture of dry neem leaves and ashes in barrels of peanuts. "I put a thin coating about every foot. It has been almost impossible to keep peanuts here for any length of time without serious damage by the weevils. The people here use a powder of DDT and Malathion, which seems very dangerous when they intend to eat the peanuts." Why did it not work, since even wood ash by itself is supposed to be effective? The book Natural Crop Protection suggests the effect of ash is in part due to its filling the small spaces between the seeds. Newly hatched weevils have more difficulty finding partners and are forced to deposit all their eggs on a small number of seeds, thus preventing an explosive buildup of populations. Even a large amount of sand is often effective. Perhaps this experiment should be repeated, mixing the ashes thoroughly with the seeds rather than layering them.

INFLUENCES OF NEEM ON NEMATODES. "There is evidence that leachates from the litter of certain trees and shrubs [Ed: water that has soaked through the litter] have nematicidal properties, e.g. Azadirachta indica (neem), Ricinus communis (castor bean) and Leucaena leucocephala." Farmers in Sao Luis put 1 kg of neem leaves per square meter in the soil (25 cm deep) before planting carrots in order to control soil nematodes, according to Dr. Warwick Kerr in Brazil.

PESTICIDE FROM SEED OF THE NEEM TREE MARKETED IN FLORIDA. The following is abstracted from HortIdeas: "Margosan-O, the first commercial insecticide derived from the seeds of the neem tree (Azadirachta indica), is registered by the Environmental Protection Agency and is being test marketed. So far its official use is limited to greenhouse use on bedding plants, potted plants, foliage plants... and other non-food crops." This formulation is used as a systemic insecticide. That means that rather than just being located on the surface it is moved throughout the plant following drenching of the soil. It appears to be practically nontoxic to mammals, birds and many beneficial insects, including honey bees. It is also biodegradable.

SOMETHING NEEM WILL NOT DO. There has been a stream of reports concerning how extracts from seeds or leaves of the neem tree can control various insects and even some fungal diseases. Unfortunately, a study in England has shown that azadirachtin, the principle active ingredient from neem, has a negligible effect on the feeding behavior of slugs. (This information taken from HortIdeas, March 1992, p 33.)

CAN A "PESTICIDE TREE" SUCH AS NEEM HAVE SERIOUS INSECT PESTS? The ILEIA Newsletter (March 1990) says that a scale insect, Aonidiella orientalis (oriental scale) is often associated with neem trees in Africa and elsewhere. It is not harmful under normal conditions, but outbreaks can become serious when plants are stressed. For example, the drop in groundwater level when Lake Chad dried out led to an outbreak.

"Several scale insect species exist on neem, avoiding the insecticidal components of the host by uptake of plant juice from the phloem. This is practically free of azadirachtin," the major insect control chemical in neem. They conclude that fear of a pest like the psyllid that almost wiped out leucaena in Asia is not justified, but beware of monocultures of neem (i.e. large plantings containing only neem trees).

DEVASTATING DISEASE OF NEEM TREES IN WEST AFRICA (1992 report). We are suddenly hearing from many in our network about this disaster. Mike Benge with USAID phoned to alert us to the problem and to say that they were sending a team to investigate. Steve Maranz in Niger writes that the neem disease has now reached all the way to Senegal. [Ed: That's as far west as one can go in Africa.] "It should be noted that to the villagers here, none of the products and services rendered by neem compare to its value as a shade tree. When there is nothing in the bare landscape between you and the blazing sun, the thick shade of a neem is heavenly. So much more the loss, then, when a 20 year old neem tree dies." On a related note, Steve writes, "I saw that our cowpeas were infested with beetles (I assume the bruchid beetles one reads about). I asked our field technician if he had ever used neem oil to control these pests. His answer was interesting. He said he knew it was effective, but would rather lose half his cowpeas than have to taste neem in his food. This is from someone who eats kola nuts every day, which are as bitter as quinine."

Steve sent a copy of a letter from George Eaton, director USAID mission to Niger written to the United Nations representative in Niger (and directed toward the broader development community) concerning this disease. Because of the importance of this problem, I will quote at length.

"Early this year the Government of Niger requested assistance from USAID/Niger to carry out an investigation and determine the nature of the disease. ...an investigation was conducted by plant pathologist Dr. Paul Batra in June/July. Dr. Batra confirmed the existence of an apparently widely dispersed disease affecting large numbers of neem trees. ...[He] collected plant material and soil samples which were analyzed in the United States. The disease has been provisionally diagnosed as an infection by a soil-borne fungus." [Mike Benge says they are still unsure of the cause.]

"Subsequent investigations by CARE/Niger staff in the Maggia Valley have confirmed that a very high percentage (100% of their sample) of the mature pollarded neem [i.e. the tops cut off, probably to use in firewood] and over 15% of the younger neem were affected. In addition 100% of the 1991 planting stock and many private woodlots are affected, as well as neem seedlings in the Tahoua nursery. As a result, CARE/Niger has proposed no further planting of neem until further notice.

"Subsequent investigations in and around Niamey by USAID/Niger staff have confirmed a high incidence of the disease in mature trees planted around town, ... in the Niamey Greenbelt, as well as in younger trees in several urban plantations. ...it has been noticed that the outer layer of the cambium of diseased trees (just under the bark) is bright red. This is true for trees that show external signs of the disease (e.g. a dead branch) as well as for those that do not yet show these signs. We are in the process of obtaining samples [elsewhere. If the same symptoms are present], this would provide a way of more easily diagnosing the disease at an earlier stage."

He then explains how neem was brought from the Indian subcontinent to Sudan in 1925, from there to Nigeria in 1935, then to Senegal in 1944 and Mali in 1953. It presumably came from Nigeria to Niger in the 1940's, where it is the principal species for reforestation (currently 2 million trees). "Given the high probability that most neem planted in West Africa come from a very narrow genetic base, it is expected that little resistance to this disease is likely to be found in the local population. USAID, ICRISAT Sahelian Center and possibly others are continuing to study the problem."

This last statement should be expanded. Sometimes a single packet of seed planted for evaluation gives such good results that a large project develops from its offspring. Possibly every seed in that packet came from one or a few related trees. There is nothing wrong with this in itself. But if large acreages are planted and a disease or insect problem arises that seriously harms the trees, it is possible that every tree will be equally susceptible. In the tree's country of origin a lot of genetic diversity would exist, possibly including resistance to the current problem.

An example of such vulnerability might be the kiwi fruit industry in New Zealand. At a New Crops Symposium, a scientist from New Zealand said that kiwi fruit was introduced to his country some years ago by a missionary who brought seed from China. He said it is quite possible that every seed might have come from a single fruit. They are working now to make sure there is a broader genetic base by bringing in plants from China.

Have you had such success with a tree species that thousands of trees might someday be planted? Can all the trees be traced to a single packet of seeds? If so, you should consider obtaining additional packets from different locations, preferably from the center of origin of that tree. If you have one variety of a species that is particularly desirable, e.g. a particular kind of leucaena, it is especially likely that it has a limited genetic pool to call upon in time of need. In a case like this you should seek out additional leucaena varieties, even if some are not quite as good for your purposes as your favorite.

This is also a good time to mention again how important it is to have as wide a number of species as possible making up the core of your development efforts. As any one species becomes more widely used, the likelihood that an epidemic might occur increases and the greater the damage it can cause your program.

Later, Mike Benge with USAID sent a copy of a telegram he received from scientists working on the problem, which I summarize: "While there are still many neem trees (particularly in plantations) that continue to suffer from decline, many other neems (in villages, along roadsides and in the Majjia Valley windbreaks) have leafed out and gone through a period of unusually heavy flowering. In some cases the same trees have flowered twice in the last several months. While this is a hopeful sign, it is still too early to tell whether the new foliage will be maintained. We are continuing to monitor the situation closely."

The disorder is clearly distinct from the neem scale insect problem reported in the area. No evidence was found supporting earlier reports that a verticillium fungus is causing the disease. In fact there is no evidence for any "primary infectious disease." Three fungi have been isolated at ICRISAT, but are believed to play only a secondary role. There are no signs of either viruses or mycoplasma-like-organisms. "Hodges, Beatty and Boa have concluded that the disorder resembles a type of disease commonly known as 'decline' and is most likely caused not by a pathogen but by one or several types of abiotic environmental stresses."

TEPHROSIA VOGELII FOR INSECT CONTROL AND GREEN MANURE.

Several members of our network wrote us about this plant for different reasons.

Beth Adams wrote from Malawi, "I planted several rows of leucaena trees on the edges of terraces, for green manure and erosion control. They are doing well and beginning to flower. I've found a shrub that seems to be much better though, fish bean or Tephrosia vogelii. It produces an incredible amount of leaf matter, grows very quickly, and is very easy to establish.. I planted them about 2 feet apart and now, 7 months later, they are almost a solid wall. They are not used as fodder."

"I have been very impressed with fish bean as an insecticide. Some of my students told me they had used the leaves to kill caterpillars, so we tried it. It killed every caterpillar overnight. It was incredible since most natural insecticides don't seem to work that quickly. We did an experiment on an okra crop that was full of aphids using Malathion, tephrosia bean extract, soap (1 teaspoon per liter) and a tephrosia/soap mixture. The latter had the best results, tephrosia and Malathion were about the same, and soap was least effective. We've not been able to use neem because the trees planted in 1992 keep dying back and then regrowing. So I am encouraging students to plant tephrosia since it is much easier to establish here and can be used as a green manure as well."

Emmanuel Soko in Tanzania is an extensionist working with Fr. Rupper, who has frequently written and shared seeds. Emmanuel shared how tephrosia is used for insect control in grain storage. "Take fresh leaves and dry them under the sun. Grind the dried leaves into a powder. Mix 100 grams of powder with 100 kg of maize to control maize weevils and the larger grain borer; with 100 kg of beans to control the bean bruchids. The chemical is effective up to three months. After that time the process must be repeated.

"The plant has many other uses. To control ticks, lice and flies, animals (cattle, sheep, goats, pets) are washed with the extract of the plant. To make the extract, fresh leaves and branches are pounded in a mortar. This is diluted with five times that volume of water before applying to the animals.

"To make an insecticide, allow the above mixture to soak overnight or boil it for 30 minutes. Add a bit of soap to help the spray stick to the leaves. It can be used with garden vegetables, fruits and field crops, to control termites, ants, beetles, aphids, cutworms, various bugs and weevils, stalk borers, flies etc.

"In the evening the walls of the room, especially corners, are beaten with fresh tephrosia branches to repel mosquitoes, lice, ticks, cockroaches, etc. It is fed to animals for intestinal problems."

Roland Lesseps sent a copy of a fact sheet written by his colleague Andy McDavid at the Kasisi Agricultural Training Center in Zambia, from which a few excerpts follow.

"It has been used as a fish poison for hundreds of years and an insecticide for over a hundred." "Cattle deaths have been reported as a result of drinking water of poisoned fish ponds. Also, reports have been made from one village of people getting sick after eating fish poisoned with the extract. I do not advise its use as a fish poison.

"The shrub may grow as rapidly as 2-3 meters in 7 months. The compound leaves contain the highest concentration of rotenoids, which are responsible for its insecticidal effectiveness. ...Its compounds are effective against a number of different pests (tested at least 90% effective against termites, citrus aphids, red spider mites). They break down in about 7 days (2-3 days in bright sunlight)." Seeds should "be soaked in water for about 24 hours for good germination (about 90%). Plant about 1 meter apart." If very large numbers are planted, use 35,000 seeds per ha for greatest leaf yield.

"In harvesting, only the leaves need to be taken off the shrub. ... If removed carefully, the shrub will continue to produce leaves for ... extract or mulch. The most effective concentration for killing insects was found to be 20 g of leaves for every 100 ml of water. If a scale is not available, take the amount of leaves equal to the weight of an empty 300 ml coke bottle, then add 7 coke bottles full of water. ...The crushing of leaves does not need to be done perfectly; a plastic feed bag and large rock can be used." After soaking for 2 hours (NOT in direct sunlight) filter the suspension through a cloth and use directly in the sprayer.

"It is important that the spray have contact with the pest. If the pest is underneath the leaves, be sure to actually hit the pests. ...If all the spray is not used immediately, it will still be approximately 70% effective 24 hours later, IF kept out of direct sunlight." Beyond that its potency drops quickly. The "used" leaves may be reused for a second extract. Tests have not determined concentrations to use but have shown that effective chemicals are left. "The leaves contain an antifeedant, so termites will not eat it. In areas of heavy termite infestation this mulch can be very helpful."

Seeds are available from Emmanuel or Fr. Rupper at P.O. Box 1, Peramiho, TANZANIA, East Africa. If you want more than a small trial packet, correspond with them to determine how much money to send. ECHO also has trial packets.

Samuel Ratnam in Singapore sent a technical note on Tephrosia vogelii. "The tree has a resemblance to Tephrosia candida. However, its pods are larger, longer and very hairy. ... After 5-6 months of growth, the average green material per hectare is about 27 tons. The yield of nitrogen is 112 kg per ha." He adds, "It is used there mainly as a bush green manure in rubber and oil palm plantations and as a shade tree for young tea, cocoa, coffee, and rubber." His company, Inland and Foreign Trading Co., harvests and sells tephrosia seed (Block 79A, Indus Road # 04-418/420; Singapore, 0316; phone 2722711; fax 2716118).

Steve Kennedy in Nepal grew the seeds we sent him and reported back to us: "The tephrosia plants are about a year old and are three meters high. We had no insect problems until flowering, but now about 10% of the flowers have been attacked by aphids. Apparently the flowers do not have the insecticidal compounds that are found in the leaves. I have mixed dried and pounded leaves with water and used as an insect spray on ants and various kinds of caterpillars, with good effect. Caterpillars died after some hours. Spraying or even scattering dried leaves across the path of ants coming into the house stopped them for a few days. I sprayed the tephrosia solution on the tephrosia flowers and two days later had no more aphids. Other expatriates and Nepali co-workers have expressed an interest in planting and using this species in their gardens."

FIGHT MILDEW WITH BAKING SODA. The Avant Gardener newsletter reports that ordinary baking soda (sodium bicarbonate) has both prevented and cured powdery mildew on strawberries, eggplant and cucumbers when sprayed weekly at the rate of 1/4 ounce per gallon of water. Powdery mildew is a fungus disease of plants that is most common when days are warm and nights cool. The leaves have a readily visible powdery coating on top. Its incidence is increased by high humidity. In India, powdery mildew was controlled on pea plants by spraying every two weeks with garlic oil. (These generous folks gave us blanket permission to excerpt from their newsletter for your benefit. Their address is P.O. Box 489, New York, NY 10028, USA; $20 per year in USA; $24 overseas.)

MORINGA LEAVES TO PREVENT DAMPING-OFF DISEASE OF SEEDLINGS. Christoph Ochsenbein, an extension officer in Cameroon, requested seeds of Moringa oleifera because he had read they could be used to control damping off. I had heard this rumor, so asked him where he read this. It is in a table in the book Natural Crop Protection (see above). An anonymous, unpublished Filipino handbook is cited as the source. It claims that moringa leaves are worked into the soil one week before sowing. This time is sufficient to release the effective substances into the soil. This seems feasible because antibiotic substances are known to be in parts of the moringa tree. The main use is protecting seedlings in seedbeds. We will list this in a "wish list" publication we send to professors identifying certain hunger-related subjects needing research. In the meantime, if you do a controlled experiment with it, let us know the results.

BLOSSOM END ROT ON TOMATOES. While a fellow gardener and I were sharing gardening experiences the other day, he mentioned that he had added too much nitrogen and caused blossom end rot. This is a very common problem with tomatoes. A spot begins to rot where the blossom was originally attached (opposite from where the stem attaches). I replied that it is calcium deficiency that causes blossom end rot.

It turns out that we were both right. The March/April issue of National Gardening Magazine quotes Ohio State tomato physiologist Dale Kretchman, "Nitrogen fertilizer will encourage lush top growth, at the expense of the root system. The plant will get too big for its roots to supply it with other nutrients and water, and you set the stage for blossom end rot, which is really a response to calcium deficiency. There is no doubt that gardeners [in the USA] fertilize their tomatoes too much."

BUNCHY TOP ON PAPAYA. Some of ECHO's Malaysia exotica papaya trees developed what I presumed to be the disease "bunchy top." Because this is a viral disease, we did nothing to try to control it. Fruit production almost stopped, and what did ripen was so low in sugar as to be uninteresting. We cut the trees and have replanted.

Yong Lee Ming at the Tenom agriculture experiment station in Malaysia sent us some fresh seed, and some important information. "The problem may not be due to a virus. The symptom you described appears to be similar to what we have in Malaysia, but so far is not a big problem and often easily controlled. The so-called bunchy top symptom is often caused by thrips and/or a fungus." He sent us a research report done in Malaysia called "Bunchy and malformed top of papaya cv. 'exsotica' caused by Thrips parvispinus and Clado sporium oxysporum." (Write us if a copy of the article would be helpful.) Excerpts follow.

A previously unrecognized disease of papaya (cv. exsotica) was first observed on nursery plants, then in the field, where more than 50% of plants were affected. Plants showing the symptoms, bunchy and malformed tops, were slow to recover, and had almost no yield if infection occurred before fruiting.

"At a cursory glance, the symptom appeared similar to papaya mosaic virus disease which has not been reported in Malaysia thus far. Closer examination, revealed that the leaves did not exhibit the marked chlorosis and vein clearing of the crown leaves which are characteristic of papaya mosaic disease."

Subsequent research showed conclusively that the syndrome was due to the attack of thrips followed by infection of young leaves with the fungus

C. oxysporum. The fungicide benomyl alternated weekly with mancozeb gave complete control. Control of thrips with insecticide was partially effective, but not recommended. It is believed that the thrips are pollinating agents as well; inadequate pollination in papaya may lead to premature fruit drop and reduced fruit size. The cultivar exsotica (developed for its disease resistance) was more susceptible than some other Malaysian cultivars.

[It is almost impossible to hear the "s" in 'exsotica.' I missed it when I was first given this seed in Malaysia and have introduced it widely as 'exotica.' At this late date I will not try to change it back. Besides, 'exotica' has intriguing connotations in our culture and I have become attached to it. I guess this is a living example of how languages change.] For a small packet of Dr. Ming's seed, drop us a line. Bonnie and I much prefer its flavor to any of the other solo papaya cultivars.

CORNELL PREVENTIVE SPRAY is used weekly on ECHO's farm on plants which are susceptible to insect or disease. We mix 5 T (tablespoons) vegetable oil, 1 T baking soda, and 4 T Safer's soap OR 2 teaspoons liquid dishsoap (like Ivory liquid) in one gallon of water. As with any spray, test on a small area if used for the first time on a plant before spraying a large area. The baking soda is apparently helpful in fungal control (see above).

COOKING OIL SPRAY FOR HOME GARDENS. The February 12, 1991 issue of the Wall Street Journal reports that the U. S. Department of Agriculture is recommending that home gardeners use a cooking oil spray to control aphids, white flies and spider mites. "Mix one tablespoon of dishwashing detergent to one cup of oil (soybean oil was used in the trials, but the implication is that other kinds are suitable), then mix between 1-2½ teaspoons of the oil-plus-detergent with one cup of water. The detergent causes the oil to emulsify in the water so that it can be sprayed. Spray directly on plants every 10 days. Eggplants, carrots, lettuce, celery, watermelons, peppers and cucumbers have been successfully protected by the spray, but it burns leaves of squash, cauliflower and red cabbage leaves. Researchers claim that the oil spray is only about one-third as costly as commercial pesticides with equivalent effectiveness." [Thanks to both HortIdeas and Central American Development Foundation for referring us to the article. The latter added a note, "Do not use palm or coconut oil because if not used promptly they will gel within 24 hours."]

MAKING YOUR OWN BIOLOGICAL INSECTICIDES. (From Int'l Ag-Sieve, Aug-Sept 1988.) The cassava hornworm is being controlled without chemicals in Brazil. Farmers collect hornworm larvae that are infected with a particular viral disease in the field. These diseased larvae are liquefied in blenders and combined with water. The larvae can be frozen and stored. When sprayed on the crop, the virus kills 90-100% of the hornworm larvae. The method is disseminated now in Brazil and frozen virus can even be purchased. Another article reports on a U.S. farmer who uses a similar approach to control soybean caterpillars on his 500-acre farm with a bacterial disease. He grinds dead caterpillars found in the field into a powder which he freezes for use the following summer.

The June 1988 issue of the Cassava Newsletter contained a lot more details about using this method. I am passing it on in some depth not only for those who have a problem with this particular worm, but as an example of an approach that might be successful with many pests.

The cassava hornworm (Erinnyis ello) damages seed stakes, destroys leaves, and increases the incidence of blight. The field is searched for larvae that have a disease caused by the Baculovirus. You can identify them because dead or near-dead larvae are found hanging from leaf petioles by their "false feet". Use only recently killed larvae (those that break open easily and spurt a whitish liquid). Mash 10-12 large larvae (7-9 cm long) or 22 medium-sized larvae (4-6 cm long) in water and strain the solution through a clean cloth or very fine strainer so that it will not clog your sprayer. The filtered liquid containing the Baculovirus is mixed with sufficient water to spray one hectare of cassava.

The best time to spray is 5 days after the larvae hatch. As a rough guideline, apply the virus when the field is infested with 5-7 small larvae (as small as 2 cm) per plant. Younger, smaller plants need protection at a lower population of larvae than do larger plants. Inspect the field at least weekly. Larvae hide on the underside of leaves or in the apical buds. Inspection needs to be thorough because larvae longer than 5 cm are not satisfactorily controlled by the virus.

Larvae become infected only after eating the virus. They stop causing damage after 4 days and die a couple of days later. Spray in the early morning or dusk to avoid the hottest part of the day.

Only recently killed larvae should be collected. If they cannot be used immediately, place them in a container and freeze them. Thaw the frozen larvae before preparing the solution. (It might be a good idea to keep some frozen larvae in case you cannot find diseased caterpillars next season.)

In the initial experiments, larvae in the control plots (no spray) began dying about the same time as those that were sprayed. This shows that the virus can be spread easily, perhaps by wind, rain, people, insects, or birds. This allows it to reach places which the spray did not directly contact.

This work with the cassava hornworm brings to mind something I have been wondering about for some time. Suppose ECHO mailed you in a regular envelope a small packet of Bacillus thuringiensis powder (Dipel), a bacterial spore that is used widely to control many kinds of caterpillars. Would you be able to kill a few cater- pillars with it, then make a spray to kill even more, soon building up a large enough reserve for large-scale use?

I first considered this when Mac Renfro brought a brief note in an old issue of Mother Earth News to my attention. The author sprayed caterpillars, subsequently blended the diseased caterpillars in warm milk and incubated this for a time. This was then used to spray more caterpillars. The work reported in the International Ag-Sieve makes me think the warm milk and incubation might not be needed. Want to give it a try? We will send a very small amount of this harmless (to people) powder if you agree to share your results with us.

A RESEARCH IDEA: CAN AN ORGANIC CATERPILLAR CONTROL BE MADE IN A COCONUT? Bacillus thuringiensis is a common and effective organic method for control of caterpillars and other insects. Though not unusually expensive for an insecticide, its cost can be prohibitive to many small farmers. "BT," as it is sometimes called, is a living bacterium sprayed on plant leaves. Young, growing caterpillars can get a fatal intestinal disease after just one bite of a sprayed leaf. They usually stop feeding quickly and die in a day or so.

A technique has been developed in Peru for multiplying populations of a related Bacillus thuringiensis that is effective in killing mosquito larvae. This raises an interesting possibility that the BT used to kill caterpillars could be multiplied in the same manner. (We have been told that some commercial BT preparations contain the toxin rather than live bacteria. Obviously such preparations would be inappropriate for this technique.)

Mike Fennema, a former ECHO intern now with the CRWRC in Cambodia, shared with us a correspondence he had with Dr. Humberto Guerra of the Instituto de Medicina Tropical Alexander von Humboldt, Universidad Peruana Cayetano Heredia, A.P. 4314, Lima 100, Peru (e- mail: hguerra@upch.edu.pe) concerning the work. Some of our readers have access to a laboratory where they might be able to investigate this.

"Ripe coconuts that appear to be free of fungal infection are chosen. The area of the 'eyes' is cleared of coconut fibers with a stiff steel brush. A large nail, fitted with a handle, is dipped in alcohol and flamed using a lit candle. This is then used to perforate the coconut, using a twisting motion.

"The inoculum, containing some 10,000 bacteria, is introduced through the hole, then the hole is closed with a piece of cotton and sealed using wax drippings from the candle. The coconut is left at room temperature for 48-96 hours." Because their goal is to control mosquito larvae, the coconuts are cut open and the contents dispersed into ponds.

"The inoculum is being prepared in the laboratory under aseptic conditions. A better-equipped bacteriology lab is necessary, and toxicity tests should be performed. It is not recommended to pass the culture from coconut to coconut because a fungal or bacterial contaminant could appear and the Bacillus culture be lost. The toxicity test we use is to determine the LD50 of each preparation against mosquito larvae."

Large animals

"HOW DO I KEEP BIRDS OUT OF THE GARDEN?" Comments like "How can we keep birds from damaging the ripening millet?" or "How can we 'parrot-proof' our corn?" come up year after year. Bird damage to ripening grain is a common problem. Commercial methods available in the States include: sound repellents (electric, propane, pyrotechnics), taste repellents, visual repellents ("scare-eye" balloons, fake snakes), chemicals that make them timid or uneasy, and various netting or screening materials. It is common knowledge that birds quickly become accustomed to some of these and others are inappropriate for the small-holder overseas.

One relatively "low-tech" approach effective in keeping away at least some bird species is the use of a reflecting mylar tape suspended between posts. These "bird tapes" are about 1.3 cm/0.5 in wide with metallic red color on one side and silver on the other. When properly strung between rows they reflect the sun and move in the wind in such a way as to effectively continue scaring birds away.

An article in HortIdeas (vol 9, number 3, pg 26) mentions the use of mylar tape to control birds in strawberries. Drive strong stakes into the ground no more than 10 m (30 ft) apart. You will need mylar tape, strings (50 cm/20 in long) to connect the mylar tape to the post, and strong adhesive tape to secure the mylar to the strings. About 12 cm (5 in) above the ground, tie the strings to the stakes, leaving 20 cm (8 in) of each end of the string free. Make an "eye" with strong adhesive tape on one end of the mylar tape. Run the strings through this "eye" and tie. Stretch the mylar tape tightly to the next stake. Twist 3 or 4 times and attach in the same manner to that stake. This design allows the mylar to rotate in a breeze without knotting or breaking.

Suspend the tape just above the ground so it can move freely without hitting crops and weeds. Tighten it if it stretches out and replace when the shiny coating wears off (about 6 weeks in the sun). Suppliers: Modern Agri- Products (322 Main St., Lynden, WA 98264; phone 800/352-7496 or 360/354-8884; fax 360/354-8885) who carries

"Birdscare Flash Tape"-minimum order: five 290-foot rolls for $15.00 plus postage ($3 in USA); also Brookstine, 1655 Bassford Drive, Mexico, MO 65265-1382, USA, has "Sparkle and Startle"-one 200-foot roll is $5 plus postage.

Some people in Florida keep birds from landing in their pools by stringing monofilament lines (i.e. fishing line) over them. These are hardly noticeable to us, but birds see them. HortIdeas (vol 9, number 4, pg 42) says that a similar approach is used to protect corn and berries. Drive 2-meter/6-foot stakes in the ground around the garden. String the line at about eye-level around the perimeter of the plot and criss-cross it in the middle. According to Cornell University biologists, the reason for success of this technique may be that the fishing line mimics the "impedimenta" warning strings spiders construct near their webs to keep birds from flying through them and destroying their work.

Rosalyn Rappaport, author of Controlling Crop Pests and Diseases, says that West African farmers bend the sorghum heads over when it is nearly ripe to make it hard for seed-eating birds to reach the grain. She also mentions "humming tape," which involves stretching video or cassette tape between posts. When a breeze blows over the tape it hums, which scares birds away. The tape should be about 5 mm wide and should not break when pulled. How you string the tape is crucial. Place posts 4-5 m/15 ft apart and stretch tapes tautly perpendicular to the prevailing winds without any twists. If wind direction is variable, orient them at assorted angles. Hang them high enough to be above the crop at maturity. When protecting large areas (0.5 hectare/1.2 acres or more), place lines 10-20 m/32-65 ft apart. Video or cassette tape will stretch more than commercial tapes and should be replaced every 5 or 6 weeks.

One farmer told us that shooting birds worked fine for him until they learned to avoid the field he was hiding in. He then found that if two people walked into a field and only one walked out, the birds would return. Apparently birds can't count. Some farmers kill one bird and hang it from a stick in the field to scare other ones away.

Tom Datema said that farmers in Sierra Leone keep birds from eating newly planted corn seeds by planting in cone-shaped holes about 20 cm deep. By the time the birds can reach the seedlings, they are too big for them to bother.

Joy Niland in South Africa wrote, "An idea which has proved quite effective in some places is to secure thin, dark-coloured string in a zig-zag pattern across the bed. The string should be about 3 cm above ground level. When the birds try to walk in the beds they trip over the string and generally fly off to less hazardous places. The string also acts as a deterrent to small animals."

If you try any of these methods, please let us know your results. We would also like to hear of other approaches to bird control that you or farmers you work with have personally found to be effective.

WHEN CRAB BURROWS CAUSE WASHOUT OF CANALS. David Ramse asked what he could do about this plague of his work in Nepal. We passed the question on to Dr. Bryan Duncan at Auburn University's International Center for Aquaculture. "I have had to worry a lot about crabs in my coastal pond work, and know of no easy preventive measures. One simply has to patrol ones dikes, canals, etc. and stop crab activity as soon as it appears. Here are a few 'home remedies.' (1) Introduce quicklime, pesticides or other noxious substances into burrows. (2) Introduction of fine rice bran into burrows is said to foul the gills and cause suffocation. (3) Use a stick with a metal hook on the end to pull the crabs from the burrow. (4) Let your imagination be your guide." If any of you have a proven method let us know.

KEEPING ELEPHANTS OUT OF THE FIELDS. I always imagined that elephant damage to a field was akin to hurricane danger at ECHO-it could happen but it might be years before it does. This view changed when I visited Kristin Kroll at her Food for the Hungry project in Marsabit, Kenya. Her experimental plot of Buhrow's white desert sweet corn had been destroyed just before my visit. (It had been doing well and was almost ready to harvest, by the way.) If I recall correctly, elephant damage was so prevalent that people seldom bothered growing crops. Elephants also can be dangerous. Two farmers and a little girl had been killed in the past year, I was told, when they accidentally came across elephants after dark. Kristin was able to obtain a grant for an electric fence, which I understand admirably controlled the problem. But what alternatives are available where an electric fence is too expensive or might be stolen?

A Mennonite missionary told me that some 70 years ago in Tanzania the British government wanted to keep elephants north of an area where crops were grown. It was bounded on two sides by two large bodies of water, I believe he said about 30 miles apart. The government constructed a trench approximately 4 feet wide and 4 feet deep between the two bodies of water. Elephants reportedly are so large that they will not try to cross such a trench. I mentioned this to Harrison Akabala from Kenya who visited ECHO. His face brightened and he said, "That is how farmers near the river keep hippopotamuses from their fields. They dig trenches."

Do any of our readers have first-hand knowledge of this technique, and how well it works, or of the old project in Tanzania? Someone told me that elephants will fill in a trench to cross to the other side. I can also imagine that if the land is sloping, the trenches could cause erosion. And if the land is flat, they might fill with water and lead to mosquito-born diseases or bilharzia. This is a problem I never expect to face at ECHO, so we would like to hear more from those with experience.

The following is excerpted from material from George Atkins. "Henry and Jill Neusinger went as volunteers to Sri Lanka where they developed a demonstration smallholding. Although they had some fencing, in the early days they lost most of their crops and some fruit trees because of the elephants. So Henry set about developing an elephant-proof fence and he managed to create one that really did work!

"The fence consisted of stakes about 2 feet long and 6 inches in diameter. The idea was to bury them in the ground with the points up. With the top sharpened the elephant cannot or will not put his foot on them. No damage is done because elephants kick forward when they walk. The points extend 6 to 9 inches above the ground. This height is very important. Too high out of the ground and the elephants pull them out, or push with their feet and lever them out of the ground. They are very intelligent and if they think they can push out the stakes they will. Of course, if the stakes are too low in the ground, the elephants can just tread on them. So they have to be high enough that the elephant cannot tread on them, yet not so high that he can push them over. They must also be pointed so he cannot get a grip on them with his trunk and pull them up.

"They did trials with tame elephants and tested 5 different methods: distance between stakes, height, point and no points. The only method that succeeded had 9 inches (23 cm) between stakes. The fence is 5.5 feet (1.7 m) wide and runs around the perimeter of the village. It took a lot of effort and expense to build a fence like this, but the village people were losing something like $8,000 worth of crops a year, less than the cost of the fence. They used hardwood. Maintenance consisted of spraying with herbicide to keep down the growth on the stakes. If white ants got to the wood, they also had to spray with pesticide. They expect it to last 20 years."

Jim Ardill in Ethiopia wrote details of a similar technique. "Strong wooden poles, about 15-20 cm diameter and 1 meter long, are sharpened on one end and driven or dug into the ground until about 25 cm are exposed. (Leaving the upper end flat makes the driving part much easier.) Cut the exposed end into a sharp point. Position these spikelike poles at about 30-40 cm intervals in a band about 2 meters wide for a barrier to elephants. Clean off the bark to make the poles slippery and make sure any knots or protrusions are removed (making it difficult to grasp with the trunk). Treat the poles with tar or diesel oil to enhance the lifespan, or a similar pole can be made from concrete. I trust that these ideas will be helpful to someone."

PROTECTING TREES FROM GOATS. This item is excerpted from Rurcon News. "Axel Bosselmann, writing from the University of Tasmania, describes how he stopped his goats from ring-barking and doing other damage to trees. He painted the trees with a mixture of goat, chicken and cow manure, and mud slaked with water or diluted urine. The mixture was applied at the level of his outstretched arms to the bark, branches and twigs and lightly over buds and leaves. It proved effective in keeping the goats away for about a month during the heavy rains before the trees needed repainting."

Roland Bunch in Honduras says, "In Bolivia some years ago, I stumbled across some villagers who had painted some eucalyptus trees with a mixture of water and goat manure, much like your recipe. This had completely stopped the goats from destroying the trees. I would guess this would work with many animals that are territorial in nature."

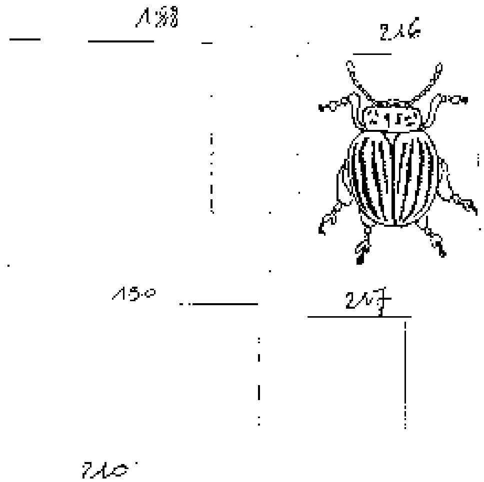
"HOW CAN WE KEEP GOATS AND OTHER ANIMALS FROM EATING TREE SEEDLINGS WHEN FARMERS PLANT LEUCAENA?" The following is adapted from a discussion of this problem in the March 1985 issue of the Heifer Project Exchange newsletter (free from Heifer Project, P.O. Box 808, Little Rock, AR 72203, USA; phone 501/376-6836).

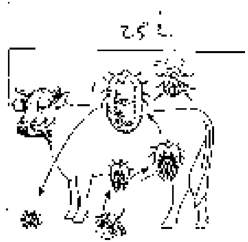
(1) The nursery must be surrounded by a fence. An effective and inexpensive fence for goats can be built by cutting thorn bushes and stacking them around the nursery. (2) Convince farmers to control their animals before the project starts. This will be more easily done if they

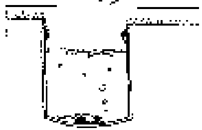
are told and believe that the trees will later be a renewable source of food for their animals. (3) Use the "bare-stem" transplanting method to help the seedlings survive grazing by animals. Follow these steps:

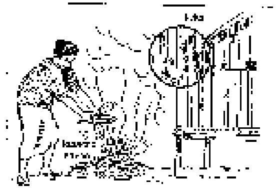
Start the nursery at least three months before the rainy season, so that the leucaena seedlings will be at least three feet tall when the rains begin. Soak the seed bed thoroughly before transplanting, so the seedlings can be pulled out of the soil easily. Strip all but the top leaves off the seedlings. If the uprooted seedlings will not be planted for over 12 hours, pack the roots in mud to keep them from drying out. Plant a high number of trees per acre (at least 3,000). Goats will be more likely to eat only the lower leaves and move on to the other trees when the planting is dense. It is better to develop a certain area well and expand the reforested area each rainy season than to spread the trees too thinly. There are three reasons for the success of this method. (1) Because the seedlings will have almost no leaves until the grass turns green, goats and other animals are less likely to be attracted to them. (2) The seedlings can better survive grazing because the root system is already quite well developed. (3) When the leaves start to appear, the seedling is tall enough that the lower branches can be grazed and the upper leaves will allow the tree to grow and establish itself.

IGUANAS ARE A GARDEN PEST for Cory Thede in Brazil. His trials (about 600 miles up the Amazon) were devastated by various lizards. He reports: "The iguanas are 1-2 feet nose to tail, with green/brown/black colors. They eat both false roselle and katuk, but not chaya. Now that we have a dozen cattle, I'm succeeding with vegetables I couldn't grow here two years ago, thanks to the manure. ...Part of the success is that I avoid the plant-eating lizards and ants by hiding or 'camouflage planting' in weeds rather than on bare soil, which the people prefer around their houses. By planting the seeds among weed vines, the seedlings are not found among all the leaves.









iguana

"Some control the iguanas by draping old fishnet over seedbeds for transplants. The elevated gardens are easily covered. [Most gardens are on raised platforms.] Seedlings can grow up through the net, and iguanas/lizards avoid it. I killed a few iguana pests in rat traps. They hide in scrap woodpiles, so keep these away from the garden. In another area

(Jurut area in N Brazil), iguanas ate the pigeon peas, but in Santarem, they didn't touch them-perhaps from the resemblance to a similar-leaved stinging vine that grew as a yard weed in Santarem."

KEEPING MONKEYS AND BABOONS OUT OF YOUR CROPS. William Boykin in Zambia asked if anyone in our network has found a way to keep monkeys from fruits, vegetables and peanuts (other than a gun). We asked for your ideas on this and many members of out network contributed helpful solutions. Be forewarned that this article contains some graphic descriptions of controls used in the field which we do not endorse.

Fr. Gerold Rupper in Tanzania sent us the following. It involves a plant that is an old "friend" to our readers- sunn hemp. Sunn hemp is receiving widespread acceptance as a green manure in East Africa. The species they grow is Crotalaria ochroleuca. Fr. Rupper writes, "Early in the campaign for planting sunn hemp (also called zanziberica), we got a report from a youth group that monkeys had been afraid to traverse a belt of sunn hemp around their field of maize. I could not ask the monkeys why they did so. But one can imagine that first of all it is a strange sight to see sunn hemp growing together and forming a barrier.

Secondly, the husks give a clattering sound, which may disturb the monkeys. [Ed: the word "crotalaria" comes from the Greek root 'crotal' meaning a rattle or castanet. The genus for rattlesnake is Crotalus.] Thirdly, if they are caught stealing maize, it is almost impossible to flee through the sunn hemp field as the branches form a rather strong network like wire. In the case of maize [corn] there is some synchronization between the maize and sunn hemp. The husks of both crops form about the same time (depending on the maize variety). People let the corn dry in the fields, at which time the barrier effect of sunn hemp becomes important. We have developed a new method of planting sunn hemp. Two rows of maize alternate with one row of sunn hemp. Here the maize is well protected against monkeys.

"By the way, here is another story. Some years ago Tanzania feared an invasion from South Africa. People were told to dig pits and cover them. Of course, before people went into hiding, snakes and other reptiles made their home there. So we sunn hemp people told them to grow sunn hemp. The plants form a solid black coverage where chickens etc. feel very safe from preying birds. If an invasion had come, they would have never suspected that sunn hemp fields are the best air shelters, although not yet listed as a war technology."

Fr. Rupper's comments about how the upright plants fall into each other helps me understand a problem we have had. ECHO grows only very small plots of each plant for our seedbank, perhaps only 2 rows deep. The sunn hemp plots usually look terrible because they fall over. Apparently that is what they are supposed to do, but in the field they fall into each other and so hold each other up. There must be a sermon illustration in there.

[ECHO can send a small packet of sunn hemp seed; see the chapter on soil health for more information. We usually also send another species developed by the University of Hawaii, Crotalaria juncea. You can determine which does best in your conditions. People in Tanzania can contact Fr. Rupper at St. Benedict's Abbey, P.O. Peramiho, TANZANIA. He says that people in Zambia can obtain seeds from Ginnie Goodfellow, Box 61, Siavonga; Marleen Kramer, Dioz. Development Committee, Box 450014, Mpika or White Fathers Missions in Mbala, Kasama and Mansa dioceses.]

Sina Luchen with the Ministry of Agriculture in Zambia sent suggestions on controlling monkeys. "Some years ago I happened to stay in a place where monkeys were a major pest. From my experience, the most effective control method against monkeys is the use of a sharp pitched bell in the field which is rung at intervals of about 30 minutes. This need not be a complicated bell. A small metallic object struck against a hanging piece of rail or old plough disc is adequate. Monkeys are frightened at the sound of the bell. Clearing vegetation around the fields also helps, as monkeys prefer to hide in the bushes surrounding the field to scan for human presence before moving on the crop.

"I stayed where there were pet monkeys for 8 years and learned a few things about their behavior. Monkeys fear cattle. The sight of cattle sends a monkey in a frenzy panic. Our monkeys used to help us detect the presence of stray cattle in the unfenced orchard. Maybe there is a way to use cattle in fending off monkeys."

Cheru Tessema in Ethiopia asked local farmers how they keep monkeys out of their fields. "They catch one monkey in a trap and paint it so that it is a different color than the other monkeys. When they set the differently colored monkey loose it runs to join its group. The whole group runs in fear of the different looking monkey approaching them. The released monkey doesn't know that it looks different and keeps on following its group, thus driving them far from a given farm."

Rev. Herbert Perry, a former missionary in Zimbabwe, wrote in response to this method from Ethiopia. "I suspect your report is somewhat incomplete. Studies of monkey life and behavior have been conducted over a number of years by field workers who routinely dye a monkey so that it may be identified and observed over a period of time. As far as I know, there is no evidence that the alteration in color in any way disturbs the rest of the clan."

"In Zimbabwe monkeys and baboons are frightened away in a way similar to that report, except that instead of paint farmers use the animal's own blood. [Ed: This becomes gory and neither I nor Rev. Perry recommend it. However, it is worth knowing about people's practices.] After trapping a single animal, they strap it securely to a board and proceed to flay large areas of the animal's body, releasing it as a bleeding mass of screaming pain. When this animal attempts to rejoin its compatriots, they indeed are frightened off. Eventually, of course, the wounded animal dies. It strikes me as being unnecessarily cruel and inhumane." If any readers have first-hand and successful experience with the painted monkey technique, please send us every detail you can think of about the process and its effect. It might save a lot of animals from being tortured.

J. D. Balarin in Kenya says that monkeys were a pest on the large banana plantation on the Baobab Farm. "We used a dog on a running line as a deterrent and it worked. A less gruesome solution."

C. H. Hansen in Zimbabwe wrote concerning the monkey painting. "When I worked in the copper belt in Zambia a neighbor told me about the same trick: catching and painting a baboon with bright colors. Only they also drenched it in perfumes and evil smelling chemicals. He said that scared off the troop with the victim in hot pursuit and that they would eventually turn around and kill the victim. Of course, this just moves the problem to some one else's farm."

Fr. Gerold Rupper in Tanzania wrote again about monkeys. "After all you have to kill them if you do not want to simply drive them away from your own field into your neighbor's farm. The common method in this part of Africa is to locate the herd of monkeys. Then you fix a large net on trees for a length of 30 meters. The 'killers' hide themselves behind thick trees with knob-kerries (sticks with knobs). Another group of men, in the very early dawn, chase the herd toward the net. They bypass the trees with the men in hiding, arrive at the net, try to climb it, and are caught in its meshes. They are then killed by the men with knob-kerries. The tribesmen hired for this cruel work get to eat the monkeys." Fr. Rupper prefers using the borders of sunn hemp to protect his own field.

Roger Sharland in Kenya has worse problems with baboons, followed by monkeys, jackals, porcupines, squirrels and rats! He wrote, "After a time of telling people 'We know the problem but can't help,' we decided to do something about it." Someone suggested a development organization buy baboon tails, but that would lead to dependency. He realized that baboons were not always a problem and are not as bad everywhere, so they began interviewing older men and seeing what other communities are doing. I report what was told to Roger, even though some are gruesome.

The common principle seems to be to make the animal so afraid of man that it will not risk coming near your patch for food. In the past people lived in larger communities and had a relatively smaller periphery to defend against animals. People then waged war continually on baboons who became afraid of man and looked elsewhere for food. Some folks located where they roost then went on a baboon hunt. They would burn around the tree or rock and shoot large numbers as they came down. For those who use bows and arrows, this tends to be a big social event. One solution is to encourage eating baboon meat. One medical assistant shot a baboon but did not kill it. It ran away and he has not had trouble with baboons since, even though he is in an area that has a lot of problems with baboons.

Another solution that Roger thinks is practical and seems to work is to put chili powder on the paths that the baboons always use in coming to the garden. Baboons always rub their eyes when they sit down, getting the powder into their eyes. This either frightens them away or makes them easier to shoot. Supposedly in one region baboons became afraid of men but not women, so the men would dress as women and carry a short bow under their skirt, though Roger says this presumably would not work often!

Continue to let us know other ideas you have. It is a pressing problem for many communities.

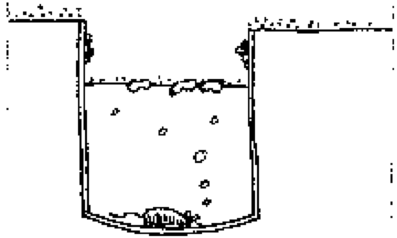
PORCUPINE CONTROL. Michi Vojta, a Peace Corps volunteer in Kenya, wrote, "One problem that discourages planting of tuber crops (sweet potato, cassava, etc.) is porcupines and other burrowing animals that substantially reduce harvest. Any suggestions to protect foods from the burrowing ones?"

Porcupines live in many habitats, from tropical forests to sandy semi-arid regions, and create extensive underground burrows with several entrances where they shelter and breed. Most are nonselective vegetarians and can be major pests in orchards or areas of reforestation by eating all parts of seedlings and girdling mature trees. In cultivated areas, they may damage root and tuber crops, pumpkins, melons, maize, vegetables-and irrigation tubing. They usually forage alone at night. Porcupines are hunted by large birds-of-prey, wildcats, pythons, scavengers, and even, in various countries, for human food.

Joe Brooks with the Denver Wildlife Research Center writes that porcupines in Pakistan died when they ate bait set out to poison wild boar. The bait was wheat flour or grain, corn oil, brown sugar/molasses, anticoagulant poison (warfarin or coumatetralyl) at a concentration of 0.025%, and enough water to make a stiff dough, rolled into small balls. He suggests that since the porcupines damage root crops, it might be worth trying cubed pieces of the affected crops mixed with the anticoagulant concentrate for a bait. (See below for information about using Gliricidia sepium as a similar rodenticide.) It is also possible to fumigate the burrows with 5-10 aluminum phosphide tablets per burrow system, but care must be taken to close all entrances to the burrow system except the one to be treated.

Porcupines find their food by hearing it fall, feeling it with their whiskers, or with their keen sense of smell. K.S. Ramalingam, visiting ECHO from India, says it is important to make rat baits smell appealing with ghee butter or groundnuts, and to stir them with a stick to avoid imparting the human smell. We have heard of fresh mint tea being poured on the ground or sprayed on plants in Thailand as a rat repellent; similar techniques might work for porcupines. To keep rodents off the bark of young trees, farmers in the Solomon Islands wrap them with a local thorny vine and make bamboo "collars" for the trees. Indian farmers grow sunflowers and build perches to encourage owls and birds-of-prey to perch in their fields and eat rodents. Might the sunken bucket trap (see below) be adapted for porcupines? If anyone in our network has more ideas for control of burrowing animals, please let us know so we can share your idea with others.

SUCCESS WITH HOMEMADE MOUSETRAP. Barry Rands in Mali reports that his gardener recently caught 150 mice in one night with four traps in their garden. Here is what he does. Barry emphasizes that this is not his idea, but is borrowed from local folks that have been doing this for years. He has popularized the technique by including it in his extension program.



a succesful homemade mouse trap

Remove the top from a 20 liter oil can and set the open can (or similar size container or bucket) in the ground so the top edge is flush with the surface. Fill the container water to within 8 cm of the top. Sprinkle sweepings from a millet threshing floor on the surface and around the trap to provide both camouflage and bait. Replace with fresh bait each evening. Other materials that would float would probably serve the same purpose. The mice come at night to eat, drink or play (they are not sure why the trap is so attractive) and fall into the trap by the dozens and drown.

Three or four such traps set around the perimeter of a small (1,000 m2) garden should be sufficient for rodent control, depending on the severity of the problem. Where containers are in short supply you can dig a 40 x 30 cm deep hole then line it with clay or cement to make it hold water. He has also successfully used a brew made from the pods of Acacia nilotica as a sealant.

When floating camouflage bait is not available, he has successfully used two pieces of cloth stretched over the trap with a 5 cm (larger if your rodents are bigger) gap in between. A bait such as millet, corn or other grain is then placed on the cloth and somehow the mice manage to fall in!

There is reference to a similar trap in Natural Crop Protection, which suggests floating a few peanuts and placing a generous ring of peanut butter 3 cm below the rim of the container.

GLIRICIDIA SEPIUM (MOTHER OF CACAO, MATA RATON, RAT KILLER) USED IN RAT CONTROL. Some people use Gliricidia to kill rats. Roland Bunch has seen the following done in Honduras. A few good-sized pieces of bark are stripped from the tree and boiled in water with about 20 pounds of corn. The corn is then tossed into the fields. Both rats and mice are killed by the treated corn. It is not as effective as regular commercial rat poison but it does work and is less lethal in case of an accident. It takes a day or two before they start finding dead rats and mice in the fields. We have heard rumors of other methods, including some manner of fermenting the leaves. We asked for help from our readers and received several responses, though not enough to provide a "recipe."

Mike Benge with USAID sent us a 1966 technical report by Harry Hockman titled "Mechanism of Rodenticidal Activity of Gliricidia sepium." The author claims that it is commonly used in Central America as both a rodenticide and an insecticide.

Dr. Hockman isolated a substance called coumarin from the leaves of gliricidia. Although this compound is itself not especially toxic, it is converted by bacteria into dicoumerol. This is chemically so similar to vitamin A that it interferes with the normal role of vitamin A in permitting the blood to clot. This was shown in 1948 to be effective in killing rodents. It is not a rapidly acting substance, but repeated doses result in fatal hemorrhages within a few days. Rats fed baits containing dicoumerol feed freely and do not develop the bait shyness that is so common with other rodenticides. This eventually led to the well known rat poison D-Con (which is actually not dicoumerol but a synthetic substance, warfarin, with a somewhat similar structure that is even more effective).

The authors looked into how Central Americans have used gliricidia. "In southern Mexico the bark or leaves are ground and mixed with damp corn flour or spread on bananas. In Panama the leaves are ground or mashed and then mixed with grain. At this point, however, there are two versions of the proper procedure. One method requires that the bait be cooked or steeped and dried before use, and the other that the uncooked mixture be used. At either locality it is worthy of note that the ground leaves are mixed with grain and allowed to ferment under the conditions of high humidity and temperature that exist in these areas." Others observed that "when rats eat it, their hair stands straight up and they bloat up and die in 4-5 days. This is the type of clinical picture one would expect from a hemorrhagic poison. Unfortunately no autopsy has been performed on a rat killed by gliricidia."

Dr. Hockman quotes research in which rats "fed a normal diet of unincubated gliricidia leaves in amount of 1.5 grams three times a day for six days showed no pathological changes. Those fed on incubated leaves in amounts of 1.5 grams three times a day for six days showed clear signs of hemorrhage in the gut, lung, and spleen."

This research went no further because there were more potent synthetic rat poisons. That may be valid for the U.S. market, but a natural rat poison that could be obtained at no cost to peasant farmers would be an enormous blessing to the third world. (Alternatively it might lead to small-scale village industries.)

I highly recommend this project to our readers within the scientific community. We need more precise "recipes" ready for village-level use with more detailed experiments to show the effect. What is the best method of preparation? With what should it be mixed, and how, to make an attractive bait? How much does a rat need to eat to be killed? How long will it be before the effect takes place? Is there much variation in effectiveness between gliricidia trees from different locations? How long and in what manner can the product be stored? Does it have a short life so it is useful only as produced on the farm, or can it be produced, stored and sold in the city?

Dr. Hockman says that "Gliricidia has two additional uses that one would not normally associate with a toxic plant. First, the young shoots are nontoxic to humans and are considered to be a delicacy in some parts of Central America. Second, silage composed of two-thirds corn and one-third Gliricidia leaves is more acceptable to and shows greater weight gains in cattle than either plant alone." It is commonly used as feed for animals Other uses include living fences, green manure, poles for yams, alley cropping and in barriers for erosion control. Most of you will find gliricidia seeds or cuttings available locally. If not, we can send a small packet of seed. We can send a copy of the article to scientists considering this as a research project. I have summarized all the general material, so the only additional information is highly technical and of no use except for laboratory research.

KEEPING RATS AWAY FROM OIL PALMS. The following is taken from West Africa Link. "Rev. Noah Kyireh, agronomist at the Nyankomasi Methodist Agricultural Project, has found an effective method of keeping rodents away from young oil palms. The young trees can be attacked by rodents, which will eat the stem right at ground level, killing the tree. Wire netting placed around the tree is not completely successful because the rodents can dig under the wire and still get to the tree. Noah Kyireh has been putting logs of dry wood around young oil palms at a distance of some 20 centimeters from the stem. It is the tropical fire ants, which subsequently inhabit the dry wood, which then keep the rodents away. He says it is much more effective than the use of wire netting, and certainly much cheaper."

Insect and mollusk pests

WHAT IS THE HUGE GRUB THAT IS EATING BANANA ROOTS? Mat Huber sent us a large beetle in a bottle of alcohol. The beetle, larger and longer than your thumb, is causing serious damage to bananas in his part of Haiti. Dr. Frank Martin identified it as Cosmopolites sordidus, considered to be the number two problem of banana in the Caribbean, second only to Cigateca disease. It usually occurs in coastal locations; in the interior it usually does not limit banana production. (However, Mat is well inland and it is serious.)

Symptoms are a listless appearance of the plant and spindly leaves. About the only thing that can be done is when digging pups, clean them with a machete so carefully that you will notice damage if the beetle is present on the pup. Use only borer-free pups on clean land. The beetle is large but not very mobile, so infestation of the new planting might not occur if sufficiently distant from infested bananas. His reference book recommends treating pups with a systemic insecticide. Their recommendation, however, is an organophosphate now outlawed in this country because it could kill people!

BLISTER BEETLE CONTROL. Sina Luchen with the Ministry of Agriculture in Zambia sent suggestions on controlling blister beetles (drawing by Rose Elwell). "Recently we had an unusually high infestation of blister beetles (Mylabris sp.) in okra. This can be a devastating pest to a number of crops including beans, cowpeas, cucurbits, and maize by eating flowers, pollen and tender pods. One recommended method of control is hand picking. This must be done with care because the beetles secrete a liquid that causes blisters when it falls on human skin. Intensive sprayings with a number of recommended insecticides could not help much. ...I came across an agricultural bulletin from Lesotho in which it was reported that farmers there were controlling the beetle by use of blue containers filled with soapy water. This insect is irresistibly attracted to the color blue, flies into the container and drowns.

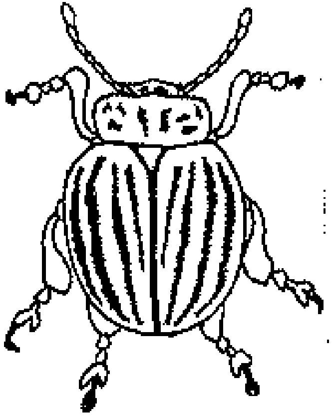
"We tried the technique. We bought 4 blue containers, filled them with detergent and placed them among the experimental plots which covered an area of 180 square meters. On the first day in an 8 hour period, 1200 beetles had drowned. It is recommended to cover the outside of the containers to avoid beetles hitting on the sides. Over a number of days, the infestation of the pest became drastically reduced. ...If the drowned insects are scooped out daily, the detergent can be reused for a number of days without having to change the liquid."

IDEAS FOR CONTROLLING CHICKPEA POD BORER. (From Int'l Agricultural Development, Jan/Feb 1994.) Chickpea leaves and pods exude extremely acidic (pH 2) droplets which repel most pests from attacking the plant. But recently the pod borer, which eats the contents of the pods, has become tolerant to the acid and has devastated crops in Asia. Pod borers have become resistant to many insecticides, and biological control is difficult because beneficial insects do not tolerate the acidic conditions.

Scientists at ICRISAT are breeding low-acid chickpeas and recommend wider planting which gives birds (like cattle egrets) paths to walk through the field to eat the caterpillars. Another creative way to control the pest is to intercrop the chickpeas with coriander, a commercial spice crop.

Coriander has an umbel flower (like carrots or Queen Anne's Lace) which serves as a "platform" for predator insects to enjoy nectar and sun and an acid-free home from which they can attack the pod borer. Research showed that using these techniques enables Indian farmers to quadruple their chickpea yields.

TRENCH TRAPS CONTROL COLORADO POTATO BEETLE. Researchers at AgCanada and Cornell University have developed a technique to control the Colorado potato beetle, a major pest not only of potato but also of tomato and eggplant. The beetle is native to Mexico, where it actually feeds on two wild Solanaceous weedy relatives rather than the domesticated potato. It has spread throughout the United States (except California), from western Europe through the Mediterranean region all the way to China. Entomologist Prof. Ward Tingey of Cornell said that the beetle will likely reach North Korea by the year 2000. It is primarily a temperate pest, and does not exist as a crop pest south of Mexico or in the Andes, where potatoes are native. If this beetle is not a problem in your area, the technique may still be helpful with other beetles.



the Colorado potato beetle

The Colorado potato beetle has become resistant to many pesticides. An innovative technique developed by AgCanada and researched by Cornell is the use of "trench traps" to catch the beetles as they walk out of fields in search of new food sources or places to overwinter.

This technique, like most successful pest control programs, relies on a knowledge of the insect's biological cycle. Farmers often rotate their potato crops to adjoining plots of land in an effort to control the beetle's damage to their plants. The effectiveness of this practice is increased by digging deep (minimum 30 cm/12 in, and up to 91 cm/3 feet) trenches around their fields and lining them with 1.5 mil black plastic mulch.

Potato beetles emerge from their winter hibernation in the soil in the previous year's field and disperse to the new field by walking up to 45 m (150 ft) from their hibernation site. They do not generally fly to find new food sources, as many other pests do. In an effort to reach the new potato field, the beetles fall into the plastic-lined trench, and, unable to crawl out, starve to death within 10-14 days.

The design of the trench is important to the success of this control method. It must have at least a 65 angle. The plastic lining is also key in the control: the beetles are able to climb out of the trenches if the plastic is clean (as when new, or just after a rain) due to their fine leg hairs, but they cannot crawl out when the plastic is coated with fine dust particles. Prof. Tingey recommends that growers place their trenches next to roads or well-used pathways so that they are redusted after a rain. Drainage of the trench is effected by perforating the trench bottom every 3m/10 feet. Though some insects may escape the trenches through these perforations, in test areas they have often been killed by a fungus, Beauveria bassiana, which thrives in the dark, moist areas below the trench. Farmers find masses of white webbed fungus on dead beetles when they peel back the plastic.

The technique can be used at both ends of the season: at the beginning, to trap insects as they attempt to enter a field, and at the end, as they leave the field to overwinter after the potato foliage is killed before the potato harvest. One main disadvantage is that the plastic does not usually last more than one year and needs to be replaced as new areas are dug.

The technique is not presently being used for control of other pests, although presumably it could be used for other beetles which disperse primarily through walking or crawling rather than flying. In Controlling Crop Pests and Diseases, Rosalyn Rappaport writes that army worms and cutworms, which migrate into crops by crawling, can be trapped and killed in ditches dug around plants. She specifies that the "side of the ditch nearest the crop must be straight, though it need not be more than 10 cm (4 in) deep. The worms cannot crawl up a sheer slope." In many situations, the plastic lining for the trench may not be necessary, and you could experiment with alternatives. (Scott Sherman used a cut-away PVC pipe buried at ground level to catch chinch bugs.) If you have field success with variations on these methods, please let us know.

James Gordley in Panama responded to this note on using trenches to control potato beetles. "I was experimenting with raising potatoes under different mulches. I would lay old carpet in my garden after working the ground in the spring. Every 30 cm I cut a slit in the carpet and inserted a seed potato. To my surprise there were no potato beetles on the plants growing through the carpet, while the plants in the next row (without carpet) had beetles on them. This was true for 3 years in a row. This method also produced potatoes 2 weeks ahead of my other plantings which were sown the same day. "Another method for beetle control is to run a handful of the insects in some water through the blender. Strain the juice and add 1/2 cup to 1 gallon of water. Spray this solution on the infected plants. Within 2 days there were no more beetles on the plants, and I saw many dead beetles on the ground. The 'beetle concentrate' can be frozen in small portions and then used as needed."

FLY CONTROL WITH MUSCOVY DUCKS. The Heifer Project Exchange quotes Jim Rankin in Togo. "People are seldom bothered by flies because they keep Muscovy ducks. For a fetish ceremony they killed a number of ducks. He opened the crops to see what they had eaten. Each one was filled with hundreds of flies."

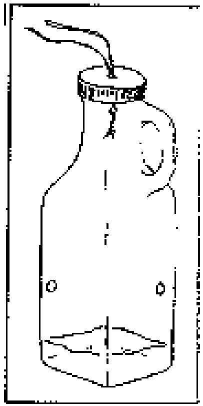
BioOptions vol 1 page 6, 1990, also addressed this subject. Don Mock, extension livestock entomologist at Kansas State University says, "The Muscovy duck and the cattle egret may someday be enlisted as a major natural weapon of defence against the housefly and the horse and deer fly." A Canadian study with dairy calves showed that Muscovy ducks removed 30 times more houseflies than manufactured flytraps, baitcards, flypaper, or flysheets. The ducks also ate spilled feed, eliminating a fly breeding site.

FRUIT FLY TRAP MADE FROM BASIL. [The following is taken from a note in Ileia Newsletter, vol 9, # 3, p. 31.] "In Keralea (southern India) fruit fly (Dacus dorsalis and D. cucurbitae) incidence is severe in mango trees. P. Reghunath and M. Indira describe a low-cost technology to combat this insect pest."

A fruit fly trap is prepared as follows: "20 g of Ocimum sanctum (holy basil) leaves are crushed and the extract together with the crushed leaves are placed inside a coconut shell, which is then filled with 100 ml water. To increase the keeping quality of the extract, 0.5 g citric acid is added and the extract is then poisoned by mixing 0.5 g carbofuran 3G. The traps are suspended from mango tree branches at a rate of 4 traps per tree. The fruit flies feed on the ocimum extract and are killed in a few minutes. In our trial, over a hundred flies per week were caught in this way.

"To successfully control pests we advise an integrated strategy. Set the traps in the trees at the above rate, as soon as fruit set begins and continue till harvest. Change the traps every week and set fresh traps. When the population of flies is heavy, give a spray with malathion 0.1% and sugar 2%. Collect and destroy attacked fruits that rot and drop down."

CATCHING FLIES WITH VINEGAR AND HONEY. Jimmy Richardson in Australia wrote, "Your note on a fruit fly trap made from basil and insecticide prompts me to send the simple plans for the one that we use. The trap uses harmless ingredients VERY effectively against the fruit fly. To make the trap, cut two holes about 4 fingers high from the bottom in the side of a 2-liter container with a screw-on cap. To suspend the trap, drill a hole in the center of the cap, then push a double width of string through and knot on the inside.



. Flies enter the container and fall into the attractant.

"To make the attractant mixture, mix 1 cup of vinegar, 2 cups of water and 1 tablespoon of honey and shake well. Fill the trap to just below the holes with this mixture and hang the container about 5 feet high. Flies enter the container and fall into the attractant. I estimate it is 90-95% effective, and no poisons."

LEAF-CUTTER ANTS ARE A CHALLENGE TO MANY. Marianne Frederick contacted ECHO with a vivid description of problems of leaf-cutter ants in Guyana. She said that farmers even tried building water filled moats around plants but the ants built leaf bridges and crossed right over. She wonders if there are controls that do not involve commercial insecticides.

Dr. Keith Andrews at Zamorano in Honduras told us of a technique using freshly cut leaves of jack bean Canavalia ensiformis. The following comes from "The use of jackbean as a biological control for leaf-cutting ants" in Biotropica, vol 11(4) 1979 pp 313-14. Five to 15 kg of leaves were placed nightly on top of and around mounds covering an area of 25 to 100 square meters for three consecutive nights. All the leaves disappeared by the following morning, the ants apparently preferring them over the plants surrounding the colony ...[including citrus, cashew and mango trees]. A single three-night treatment usually resulted in complete cessation of ant activity for periods ranging from four months to five years (when observation ended). Infrequently, very small black ants (possibly forms of the same species) would appear 2-3 weeks following treatment of the colonies. Because of their random and disorganized activity, they were controlled with small doses of insecticide.

"It is presumed that the effect of jackbean on leaf-cutting ant colonies is due to the action of fungicides such as demethylhomopterocarpin contained in jackbean leaves on the ants' fungus gardens." The ants carry the leaves into the mound where they are normally transformed by fungal activity into the food upon which they depend. That's about all the article reported, and no data was included.

Tom Post had trouble establishing neem trees in Belize because of leaf-cutter ant damage. "They would strip whole trees. I planted jack bean around the trees. When the plants got about a foot tall all damage stopped. But there was no evidence that they were stripping jackbean leaves. In fact, we placed leaves on their trails and on the mound and ants would not pick them up. A project in El Salvador likewise found they would not pick up leaves spread on the trail or the mound."

Dr. Warwick Kerr in Brazil writes that "One recent research revealed that sesame, Sesamum indicum, protects the plantations against leaf-cutter ants, Atta sexden. The ants bring it to the ant hill and it stops growth of fungi."

Leaf-cutter ants are a serious problem. Let us know if you try jack bean or sesame control, or if you have another method. There are too many unanswered questions to recommend the method with much conviction. This would be a good research project for some of the scientists among our readers.

Alfredo Petrov in Cochabamba, Bolivia shared his experience in controlling leaf-cutter ants. "I work in a semi- arid valley, 2,700 meters above sea level. Leaf-cutter ants have defoliated our peach trees, rose bushes, potato fields and tree plantation seedlings. So they are not only a problem of the humid tropics.

"The best protection for tall plants with narrow stems, such as roses or young peach trees, is loosely-wadded sheep wool tied around the stem! Ants don't like to cross it and it is almost totally effective. Local sheep conveniently deposit the necessary tufts of wool on our barbed wire fences. This method is not practical for older trees with thick trunks or for tree nurseries with thousands of seedlings.

"For trees with thick trunks, merely whitewashing a section of the trunk with lime seems to somewhat reduce leaf- cutter damage. We mix the lime with mucilaginous cactus (Opuntia sp.) juice to help it stick on longer. Perhaps the black ants don't like to cross the contrasting white background, which makes their black march easily visible to predators?

"Several Bolivians have recommended wrapping fruit tree trunks with sticky tape, sticky side outward. I haven't found this to be very practical;

in our intense mountain sunshine it doesn't last long - the tape soon dries out and turns brittle. There is a sticky liquid sold in the USA for painting on tree trunks to trap crawling pests called "Tanglefoot". Does anyone have more information on this? [Ed: This product is indeed very sticky, not affected by temperature or weather, and very effective at trapping insects until it traps a lot of dirt and no longer has a sticky surface. It does not dry out and can last several months. The price in one U.S. catalogue is $25/5 lbs-not exactly inexpensive; does anyone have experience with alternatives? See page 198 for description of using STP oil treatment as a substitute.]

"One local person suggested that I protect prized plants with a circle of sugar poured on the ground around the stem. I don't know why this would work, and haven't been desperate enough to try it yet. One successful elderly farmer has effectively protected his potato field with a barrier strip of organic debris taken from distant ant colonies. Presumably the ants avoid the smell of ants from other ant colonies.

"The other philosophy is to find the local ant colonies and kill them, instead of protecting the plants directly. This is usually done by sprinkling powerful insecticide powders around the entrance holes, a practice to which I am ecologically opposed. Since human urine contains a fungicide, I tried attacking a colony's fungus garden by pouring urine down the entrance hole. It did get rid of the colony, but took several applications a day for eight days-too much trouble for more than one colony."

Marsha Hanzi in Bahia, Brazil wrote that leaf-cutter ants are the "janitors" of a forest ecosystem. They remove weak plants and produce compost richer than worm castings, enriching the soil and preparing it to support trees. "These ants dominate the scene where most organic matter has been removed [so] if we increase the amount of organic matter on the ground (by planting leguminous trees and pruning them every two months during the rainy season), the leaf-cutters go back to cleaning out the system without serious damage to our crops and trees.

"This I can affirm from personal experience; in the first year of my permaculture system, on hardened poor clays, the ants cut everything I planted. Today, three years later, they still exist, and sometimes nibble something, but normally go next door and cut the neighbor's plants! (His soil has very little organic matter.)"

To begin building a system in highly degraded areas with leaf-cutter ants in a balanced role, she recommends planting local pioneer plants every meter and pruning them frequently to build organic matter and restore soil fertility. Bananas can also be used, three meters apart. Then she looks for leguminous trees adapted to the area; Marsha has not lost leguminous trees to ants. She uses native Ingas, Erythrina, and Gliricidia in the humid and transitional zones and plants food plants among these species. In transitional zones, she has seen cashew and guava trees growing in ant mounds; perhaps their thick leathery leaves make them less prone to attack.

One creative idea for keeping the ants off new plantings is to distract the ants by planting "enormous quantities of pigeon pea (Cajanus cajan), which has incredible resprouting capacity if eaten by the ants. Ants prefer the flowers of these to practically anything else other than, perhaps, young citrus trees, which need to be protected. Although planting sesame does work, killing the fungi which feed the young, I prefer to feed the ants and not kill them" for their long-term benefits to the soil. She also suggests that guinea fowl and chickens might help control the ant population in outbreak situations. She welcomes correspondence at: Instituto de Permacultura da Bahia, Condomnio Aguas Finas QE L4, Lauro de Freitas, Bahia, BRAZIL, CEP 42700-000; fax

55 71 378 1520.

FALLEN ORANGES FILLED WITH INSECTS. Jiwan Dewan in Nepal wrote that half of his navel orange fruit was dropping and was filled with maggots. I called Dr. Carl Campbell for help. Carl said this is a tough one to figure out, but here are some thoughts. The first step is to determine if the insects are causing the drop or if they are a secondary cause, entering after some other problem. The letter did not say at what stage they dropped, whether as very young fruit or more mature fruit. If it is the mature fruit that is dropping, then it is perhaps more likely that the problem is directly caused by eggs laid in the fruit.

Fruit drops are very serious some years in Florida. It turns out to be due to the fungus anthracnose that is attacking the blossoms combined with both thrips and midges feeding on the ovaries of the flowers. A careful look at the blooms will show if there is either fungus or insect damage. It could be that a fungicide at bloom time would solve the problem. Another common cause of fruit drop is dry weather. If it does not rain at least an inch a week one should irrigate (if that is a possibility). Citrus is very sensitive to lack of water.

It would help to know whether it is fly, beetle or lepidoptera larvae in the fruit. Here is a rough way to tell. Fly larvae have no legs, whereas both beetle and lepidoptera larvae do. Beetle larvae "look like grubs." Lepidoptera larvae tend to be longer and slimmer than beetle larvae and somewhat flattened.

If the fallen fruits are of a good size, see if there are any obvious puncture wounds. In the equatorial tropics an adult fruit-piercing moth causes a lot of problems in citrus. Usually no one even knows the moth is around. It pierces the fruit and sucks juice at night, then quickly leaves. What most people see is the fungal lesion that develops around the spot.

MEALYBUG CONTROL. In 1991, Wayne Teel in Mozambique asked about controlling cassava mealybug (Phenacoccus manihoti) without commercial insecticides. The mealybug destroyed up to 80% of the cassava crop.

Natural Crop Protection says that cow urine is used against mealy bugs, thrips, mites, and other insects in Sri Lanka. Cows are penned overnight on a concrete floor which slopes to a tank. Collected urine stands exposed to sun for 2 weeks, then is diluted with 1-6 parts water and applied to plants. Tender vegetables require a more dilute urine solution than fully grown trees, as too concentrated a solution can burn the leaves. Test dilutions on different plants.

The 1995 World Food Prize was awarded to Dr. Hans Herren for his successful efforts in finding and implementing the biological control of the cassava mealybug in Africa. Based at Nigeria's International Institute of Tropical Agriculture, Dr. Herren coordinated the worldwide collaboration (1979-1992) which resulted in mealybug control in 95% of the cassava-growing zones of Africa. Researchers found natural enemies in the pest's South American home, and tested them in Africa. The most successful was the parasitic wasp Epidinocarsis lopezi, which was released in Nigeria in 1981. This wasp has been dispersed and established throughout Africa. We hope it has reached Mozambique by now.

LEUCAENA PSYLLID OUTBREAK AND CONTROL. Pest outbreaks can be sudden and devastating. After years of promoting Leucaena leucocephala for erosion control on hillsides and an important tree in agroforestry systems, the psyllid became a serious problem in Asia in 1986. Control efforts included screening for psyllid- resistant leucaenas and introducing parasitic wasps for biological control. This "story" illustrates many important principles of plant protection and pest control: avoiding dependency on just a few species and achieving a balance between pest and predator insects. Below, you can follow the development of solutions to this problem.

FROM MARCH 1986: INSECT PEST CAUSING SERIOUS DAMAGE TO LEUCAENA PLANTINGS IN THE PHILIPPINES. Five of our readers in the Philippines have written about this problem. It is a good warning to others also that there is always danger in planting incredibly large areas to one species. The Nitrogen Fixing Tree Association (NFTA) has published a two page analysis of the problem. It is caused by psyllid insects (Heteropsylla spp.) or jumping plant lice, which have spread rapidly around the world in the past few years. The insects are native to the Caribbean and eastern Mexico, where they seldom cause severe damage because of natural predators. This suggests that introduction of predators [or even gradual natural build-up of local predators?] may be the best control. Some ladybird beetle larvae are outstanding predators, e.g. Curinus abdominalis. The insects are not spread by seeds. The most likely methods include high-altitude air movements, cargo in airplanes, or illicitly shipped live plants.

What can we learn? I would be hesitant to rely exclusively on one species of tree for a particular purpose. Leucaena may outperform most trees in your setting, but other species have exceptional qualities as well. In the long run, a mixture is better. Also, you can plant more than one variety of leucaena. Folks who write to ECHO for seed are sent four leucaena varieties for this very reason. Readers who are heavily involved in reforestation should receive the NFTA bulletins on a wide variety of species with potential for their area; write Winrock International, Petit Jean Mountain, Rt. 3, Box 376, Morrilton, Arkansas 72110-9537, USA.

FROM OCTOBER 1993: PSYLLID-RESISTANT LEUCAENA. We asked Mark Powell at the Nitrogen Fixing Tree Association what Leucaena leucocephala variety he would recommend where psyllid insects are a problem. He sent us a variety called K636, the top performer in their 'New Giants' trial at Waimanalo, Hawaii. "Although this variety has performed well especially after it achieves heights above 5 meters, it will support large psyllid population buildup which can defoliate all juvenile leaves. It has been observed that it tends to retain its older leaves during periods of high psyllid pressure." The K8 variety was one favored giant type several years ago, but it is now "disfavored due to its relatively high susceptibility to psyllid defoliation."

FROM JUNE 1992: LEUCAENA PSYLLID IN AFRICA. Mike Benge with USAID tells us that the leucaena psyllid that had such a devastating effect on leucaena trees in parts of Asia (e.g. Philippines) has reached Africa. It has been identified on the islands of Mauritius and Reunion. ICRAF and the CAB International Institute of Biological Control (IIBC) are coordinating the design of a strategy for biological control of this pest. Host- specific parasitic wasps found in the Americas as well as other natural enemies are bringing it under control in Asia. "In situations like this I do not believe that resistant varieties are the best answer. People should be cautioned not to lay too many hopes on resistance as breeding takes a long time and insects adapt so quickly and so well. They are like people, when sirloin isn't available anymore they'll eat hamburger."

IN 1995 AND 1996, Mike Benge with USAID gave us an update on the damage to leucaena trees by the psyllid insect in Asia. "The introduction of the parasitic wasp seems to have reduced the damage to a somewhat acceptable economical level." "The biocontrol of the psyllid in SE Asia has gone well with the host-specific parasitic wasps Psyllaephagus yaseeni and Tamarixia leucaenae (the region); ladybird and ladybug beetles Olla abdominialis and Curinus coerulus (particularly in Indonesia); and other naturally-occurring [controls] such as spiders." "A survey in the

Philippines conducted by Winrock...determined that leucaena is still the tree of choice by farmers. The leucaena systems heavily damaged in the past are recouping and are productive again in most places. As you know, the psyllid has spread to Africa, and there is now an effort to introduce the parasitic wasps there...the IIBC in England is involved."

USING GRAPEFRUIT TO CONTROL SLUGS? The "Letters" section of Organic Gardening Magazine contained the following suggestion. The writer lived in Oregon where she was "surrounded by slugs." She tried oyster shells, rough bark dust, rosemary, hunting them down and sprinkling salt on them and beer baits, and found them all inadequate. "Then I discovered grapefruit. After you've used the pulpy insides for breakfast, set the rinds (with a little pulp left) upside down igloo-style around your garden." She says that the slugs will hide underneath the grapefruit and die. We have no slug problem at ECHO, so we cannot verify this technique. If you do, please let us know whether it worked. This seems too good to be true, but it would be wonderful it is does work.

IRON SULFATE MOLLUSCICIDE. The horticultural newsletter HortIdeas (September 1990 and April 1992) has reviewed several reports on using iron sulfate (green vitriol) to control slugs. "Recent laboratory trials in

England support the notion that iron sulfate is rapidly absorbed by slugs which contact it and is highly toxic to slugs. ...Iron sulfate is cheap, easily available, and not very toxic to humans." In fact "it is a widely prescribed iron supplement for people suffering from anemia."

A subscriber in Spain, Brian Lynas, reports great success by spraying or sprinkling (especially following rain) a solution of iron sulfate. "For over a year I have intermittently sprayed iron sulfate solution around lettuces, brassicas [Ed: cabbage family] and any other plants which were under attack from mollusks. The concentration does not seem to be critical. I use four heaping teaspoons in a five-quart sprayer (twice that concentration if using a watering can) on the soil around slug-attracting plants. ...I've sprayed the soil and also sprayed the plants directly. There's no doubt that either is effective, especially if you can directly spray the mollusks themselves.

"The spray seems to act as a contact poison, so if the animals are wetted or have to cross a sprayed area like a leaf, they die. Unfortunately, when sprayed onto soil, the soluble iron sulfate is quickly changed to insoluble hydrous iron oxides and is ... inactivated.

"Iron sulfate burns some sensitive (usually young) plants. The damage is minor, and my impression is that the anti-mollusk benefit far outweighs the disadvantage. In fact, ferrous sulfate solution at around 3% strength is often used for correcting iron deficiencies by direct spraying on foliage.

"Regular spraying-especially after rains-around the plant bases where the creatures hide, as well as generally around the cultivated area, dramatically decreases the mollusk population with almost immediate effect. [In Mallorca] a small conical snail occurs by the hundreds of thousands. A couple months ago these were infesting a patch in which I'd planted small brassicas and lettuces. Sometimes each plant would have 30 or more snails lying around underneath. I sprayed the solution over them, and they evidently all died. What's more, it seems this killed ... the eggs also, for even now there are practically no mollusks in the area."

GARLIC TO KILL SNAILS? Drs. D.K. Singh and A. Singh at the University of Gorakhpur in India looked at the molluscicidal properties of an extract of common garlic, Allium sativum. Aquatic snails, Lymnaea acuminata, an intermediate host for parasites which cause fascioliasis of cattle, were used in the experiment. Ten snails were placed in each aquarium. The required amount of garlic cloves was minced in 5 ml water, homogenized for 5 minutes [in a blender], and centrifuged at 1000 g for 10 minutes and added to the water. [Ed: For other than experimental use, this procedure could be greatly simplified; e.g. filtering could probably replace centrifuging.] Each experiment was repeated six times. Concentrations are expressed as weight of garlic clove per liter.

The LC50 value (the Lethal Concentration required to kill 50% of the snails) was both dose and time dependent. Thus with an increase in exposure time, the LC50 of garlic decreased from 55 mg per liter at 24 hours to 30 at 48 hours and 12 at 96 hours. The LC90 (the concentration to skill 90% of the snails) at 96 hours was 36 mg garlic.

How does this compare with commercial molluscicides? The 96 hour LC50 of two synthetic molluscicides is higher (i.e. less effective): phorate is 15 mg and carbaryl is 14 compared to 12 for garlic. However, the standard molluscicide niclosamide has five times higher toxicity in 24 hours (LC50 = 12 mg) than garlic (55 mg). The authors believe that if the active ingredient were further purified, it would probably be more toxic than the best synthetic.

NEEM LEAF TEA TO CONTROL TERMITES. We seldom hear of any natural control that works with termites. Don Mansfield in Mali sent the following. "A Norwegian missionary here in Mali told me how to control termite damage to trees with neem leaf tea (Azadirachta indica). A barrel or bucket is filled with green neem leaves. They cover the leaves with water and after 4 days use the liquid against termites. I don't know whether it kills them or just keeps them away. The missionaries swear it really works.

"It has been a great success for me. Most of the time when I've used it, it has been setting for at least 2 weeks. When I see where the termites are starting up a tree or pole, I knock them and their clay off. Then I take a paint brush and paint the whole area where the termites had been on with the tea. I make sure that plenty runs down around the base. Twice I have had to do it a second time after about a week, but all the other times I have only done it once and the termites have not come back. It has been 5 or 6 months since I treated a few mango trees, and they have not been bothered since."

TERMITE-RESISTANT TREE reported by Roland Lesseps, S. J., in Zambia. "Termites here make it very difficult to establish tree seedlings in the field. In some places at Kasisi we have lost about 90% of our Leucaena leucocephala seedlings. So we are always on the lookout for a tree that is termite resistant. An excellent one is Senna (Cassia) siamea. We planted four rows four years ago (about 70 trees per row) in a field terribly infested with termites. Almost all the trees are alive and growing luxuriantly. We have coppiced them three times and used the leaves in compost piles. The cut branches make good poles or firewood. We earlier fed the leaves to cattle, then we heard at an ICRAF meeting that the leaves, though eaten by goats, are not good for cattle."

SUGGESTIONS TO HELP AGROFORESTERS REDUCE SEEDLING LOSSES FROM TERMITES. [Taken from Agroforestry Today, July-Sept. 1990 pp 4-6].

1. Select trees that are resistant to termites. These include species of Cassia, Acacia, Grevillea, Markhamia, and Terminalia.

2. Use plant extracts and minerals as protectants. These include finely chopped leaves of Euphorbia tirucalli or wood ash applied to planting holes; leaf or berry extracts of Aloe graminicola, Melia azedarach [Ed: Chinaberry, a freeze-tolerant relative of neem], Lippia javanica or Ocimum sp. (basil); and leaf mulches of Cassia siamea or Azadirachta

indica (neem).

3. Plant extra seedlings, to allow for termite losses, both in the nursery and after planting out.

4. Use containers of polyethylene tubing. Pots made of banana fibre should not be used for seedlings where termites are a threat. It is of paramount importance at transplanting to remove the plastic sleeve carefully and retain an intact soil-root ball.

5. Use healthy and vigorous planting stock. Any root pruning should be scheduled to allow sufficient recovery and repair of damaged tissues before transplanting.

6. Give nursery stock enough water just before planting out.

7. Plant seedlings on time, soon after the first annual crops are sown or when the soil is wet to a depth of 20-30 cm.

8. Provide substitute food sources for termites. This could involve leaving as much cleared plant debris as possible on the soil surface when preparing tree planting sites; using organic manure in planting holes;

ring weeding rather than clear-weeding stands of young seedlings; retaining grass residues as mulch in and around planting holes; and placing a row of cut banana pseudostems along nursery perimeters.

9. Apply spot treatments of a controlled-release granular formulation of carbosulfan (0.3 to 1.0 grams active ingredient per plant). Other non-persistent insecticides such as chlorpyrifos and carbofuran are not recommended due to severe phytotoxic effects.

Research is currently in progress on another novel approach to control of subterranean termites [which rely on fungi to make suitable food from decaying vegetation carried into the colony]. This approach is to apply fungicides to deprive them of their major food source by controlling these symbiotic fungi.

ARE BRUCHID BEETLES THE SAME AS WEEVILS? We have mentioned using cooking oil to control bruchid beetles in stored seeds. We were asked if they are the same as weevils. Good question. The answer is yes. Quoting from Insect Life, "There are two general groups of seed borers: species that feed in green or living seeds and those that attack dry seeds. The [former] deposit eggs in the seeds by means of a long ovipositor that penetrates the flesh of the fruit. The adults usually emerge after the fruits have decayed. The latter, the common feeders upon dried seeds, are known as weevils." Several generations can develop in a container of stored seeds.

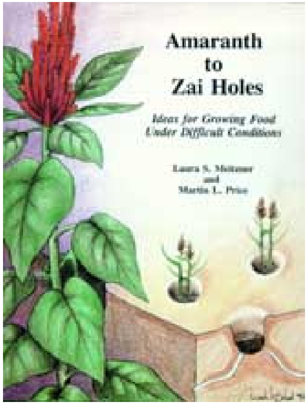
SHORT-TERM HEATING KILLS COWPEA WEEVILS. The January 1992 issue of HortIdeas reports that two Purdue University entomologists have developed an extremely low-cost technique for ridding dried cowpeas of weevils (Callosobruchus maculatus). If you have some clear plastic, a piece of dark cloth, a few rocks, a semi- sunny day, and about an hour, you should be able to eradicate the weevils in a few pounds of cowpeas.

"A simple solar heater was made by placing a 3 ft x 3 ft (1 m2) black plastic sheet on the ground, adding 1 kg (2.2 pounds) of cowpeas (spread out only one layer thick), and adding a cover of clear plastic sheeting, held down at the edges by rocks. It was discovered that the ambient temperature doesn't affect the temperature inside the solar heater very much on clear or bright-hazy days; the temperature inside cowpeas within the solar heater was 149 F 15 minutes after exposure began on a slightly hazy day at noon."

After solar heating for different times, the numbers of beetles emerging were counted (time in minutes followed by numbers in parentheses): 0 (227 adults), 30 (12 adults), 60 (2 adults), 120 (no adults), 180 (no adults). The treatment did not significantly alter either cooking times or germination percentages. The seeds did lose water, which was probably beneficial. Different types and colors were tried for the sheet on the ground (including cloth) and seemed to make little difference. This time, in all cases no adults emerged after a 45-minute treatment.

SWEET POTATO WEEVIL PROBLEMS. Matt Huber wrote from Haiti, "An insect is severely damaging the roots of sweet potatoes. What can be done?" He sent us a jar containing several of the tiny worms (a few mm long) in alcohol. Dr. Frank Martin identified them as sweet potato weevils, and made these recommendations for their control. It is very important to plant where sweet potatoes have not grown for about a year. It is also important to keep any wild relatives of the sweet potato from the field (e.g. morning glories). When cuttings are taken to start a new planting, soak them for up to 24 hours in a 1% solution of a systemic insecticide. One such insecticide is furadan. This will prevent introduction of the weevil into the new field.

He mentioned that the tubers are damaged extensively. Frank said that the observation that there is this much damage most likely means that farmers are using a long maturing variety [or are "storing" them in the field, harvesting as needed]. Sweet potatoes differ widely in time required for maturity. Matt needs to search for some short-maturing alternatives. In the meantime, harvest as early as possible.



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

9: Domestic animals

Animals are very important to the small farm. Their integration into farming activities provides uses for many byproducts of the farm. They provide high-quality food, income, fertilizer, status, companionship, transportation, labor, and much more for rural families. But seasonal feed shortage and parasite problems can frustrate people's efforts in animal husbandry. This chapter highlights information and resources on raising and caring for animals in the tropics.

Working with animals

NEWSLETTER ON ANIMAL HUSBANDRY IN THE THIRD WORLD. When people contact ECHO with questions on animals in development, we usually refer them to Heifer Project International (HPI), a group which specializes in that area (much like ECHO "specializes" in plants). If your outreach into the community includes working with animals, you will find the Heifer Project Exchange to be an excellent complement to ECHO Development Notes. The 4-page newsletter (now also with a 2-page insert called "Women in Livestock Development") is sent four times a year at no charge to development workers in the third world. They wrote that "we are happy to send it to those involved in livestock production projects upon receipt of their addresses and a description of their work." I am sure they would send it to others for a small donation to help cover expenses.

The Exchange shares with ECHO a determination to make available sufficient information so that you can act on what you read. I have not found tantalizing articles that leave me frustrated because the key practical information or address has been omitted. Articles are a mix of practical information and techniques with occasional comments providing perspective on a particular question. They also direct you to reprints, publications, and conferences on animal-related topics.

Let me pick some items from some past issues: "A goat medicine cabinet" suggesting medications that should be kept on hand by those working with goats; announcement of an upcoming seminar on beekeeping; a discussion of Caseous lymphadenitis in goats; plans for a manure-heated brooder; a method for pasteurizing milk on a small scale; midwifery for shepherds; lambing supplies check list; design for a Zimbabwe fly trap.

I especially appreciate the section called "Practical Materials which Readers May Find Useful." This is a very brief summary of articles that have come to their attention. In most cases they will send a free copy upon request from readers. If you would profit from the Heifer Project Exchange or want to receive Heifer's full publication list on development and livestock manuals, write to the editor Jerry Aaker, Heifer Project International, 1015 S. Louisiana, P.O. Box 808, Little Rock, AR 72203, USA; phone 501/376-6836; fax 501/376-8906.

LIVESTOCK FOR A SMALL EARTH: The role of animals in a just and sustainable world. Ed. by Jerry Aaker, 111 pages. The authors are all staff at Heifer Project, which provides technical training, livestock, and organizational assistance to rural community groups in developing areas. They present a theory and process of sustainable rural development which includes animals in the system because of their many benefits to the small farm family. Dotted with insights and case histories from HPI's fifty years of experience around the world, the text is a readable blend of facts and ideas. Emphasis is on the ecological and social facets of the work, although the book also provides practical suggestions for the beginner in village- level sustainable animal agriculture. It includes ideas developed by HPI such as "passing on the gift," in which recipients of female animals are required to give an offspring to another family in the community, and its implementation in several cultures.

There is an extensive bibliography on sustainable agriculture, rural development, and technical manuals on animal husbandry and related topics. This is an extremely useful book for a broad spectrum of people, from development workers to policy makers, who want to understand the key role of livestock in both the tangible and intangible sides of community development. Further information about HPI and copies of the book (send $10; includes shipping) are available from Heifer Project International at the above address.

TRAINING IN ANIMAL TRACTION. Don Mansfield in Mali asked where he could get training in animal traction. We can recommend a good book, Animal Traction by the Peace Corps (245 pp., available for about US$40 from ERIC Document Reproduction Service, EDR/CBIS Federal, 7420 Fullerton Rd., Suite 110, Springfield, VA 22153-2852, USA; phone 800/443-3742 or 703/440-1400). However, the subject is so complex that hands-on experience would be a great help.

Tillers International offers training in animal power, blacksmithing, woodworking, and international rural development. The goal of Tillers is to develop low-capital rural technology, including animal-powered agriculture, along with metal and woodworking support skills, so small farmers can achieve self-reliance. The program director, Richard Roosenberg, spent three years working with oxen as a Peace Corps volunteer in Benin. The program maintains a considerable interest in Third World applications. They have workshops, internships, and specialized training for North American and international students who want to receive hands-on instruction and opportunities for low-cost research in these fields. Tillers also studies and modifies designs and publishes a technical newsletter called The Tillers Report; subscriptions are $25 for 2 years, and 15 backsets are available for $25. Write for a current publications list, which includes full-scale yoke construction plans. Workshops (1-5 days) and international development courses are given February through December on topics such as the following: ox driving and training, rope making, blacksmithing, woodwrighting, agricultural tool making, selection and care of oxen, draft horse use, animal-powered field work, sustainable pasture practices, building rural infrastructure, draft logging, road building, sweet sorghum molasses, timber framing and barn raising, etc. Tillers also has a highly competitive internship program which runs for 3-9 months from April through November. Interns are paid according to experience and skills. Write Tillers International, 5239 South 24th St., Kalamazoo, MI 49002, USA; phone 616/344-3233; fax 616/385-2329.

TECHNICAL NOTE ON OX YOKES. Tillers International also has a series of TechGuides. Titles include: Full-scale yoke plans; Hay baler construction plans; Training young steers ($3); Selecting and pairing oxen ($3); Advanced training of oxen ($8); Slip-scraper construction and operation ($4); Animal-driven shaft power ($4); Measuring draft power ($2.50);

Bricken, brakes, head yokes for restraining loads behind oxen ($1.50); Wood- framed harrow ($2.50); Manual hay baler ($3.50); Simple forecart design ($1.50); and the MOP over-the-row weeder ($3). Postage is $2 per order. Order from Tillers at the above address.

One 10-page technical note is called Tillers Tech Guide: Neck Yoke Design and Fit, ideas from dropped hitch point traditions ($3). ECHO claims no expertise in this area. But this appears to contain the kind of practical, applied, and well-illustrated information that might be helpful to you. I quote from the introduction.

"I was struck by the importance of yoke fit and design when training the first pair of oxen at Tillers. I had worked with a number of pairs in West Africa... I began training with a simple yoke like I had used in the African project. It had a pole for a beam, steel rods for bows, and a clevis extending behind the beam for hitching. After a few weeks the team pulled a stone boat willingly, but if I stepped onto it, they would stop.

"Then I placed an historic yoke on the team. They did not mind its extra weight and readily pulled the stone boat. I stepped on and they continued to pull without hesitation. A second person got on and the team still pulled. It took the weight of a third person to discourage them. I was amazed that changing the yoke permitted adding about 330 pounds (150 kg) to their load. I immediately started analyzing that old yoke and reading...about traditional yoke design and dynamics. Obviously these yokes were superior in some simple ways."

AN EXCELLENT RESOURCE FOR FORAGE SEED AND INFORMATION. I have found folks at ILCA (the International Livestock Research Centre for Africa-see note below) in Ethiopia to be unusually eager to help, including taking the initiative to get information to us at ECHO. I wrote to Dr. John R. Lazier, forage agronomist, asking if folks who read this newsletter would be able to request small quantities of seed. I realize that few of you are with research organizations or large programs of any kind. He replied, "ILCA does provide seed in small quantities to requestors, and your readers would be no exception." If you are doing a serious search for better forages for your region and cannot find seed for a particular forage plant, you might contact them for a small packet of that seed.

"ILCA is collecting germplasm of potential value to small farmers for cut-and-carry, grazing, browse and dual-purpose use (food and fodder)."

They are especially interested in leguminous forages. They also publish a forage research newsletter (about 30 pages each), but this is quite technical and would only be of interest to the few of you who do a lot with forages.

Two International Agricultural Research Centers merge. The International Laboratory for Research on Animal Diseases (ILRAD) in Kenya and the International Livestock Centre for Africa (ILCA) merged in 1996. The new entity is the International Livestock Research Institute (ILRI) and will be located in both Kenya and Ethiopia. The addresses are P.O. Box 5689, Addis Ababa, ETHIOPIA and P.O. Box 30709, Nairobi, KENYA.

WINROCK INTERNATIONAL MAY BE ABLE TO ANSWER SPECIFIC QUESTIONS ABOUT LIVESTOCK. If something comes up in your work that you cannot answer, this free service by Winrock can be quite helpful. Some of the more frequently asked questions have led them to prepare Tech Notes on the topic. These 2-4 page notes are available in English or Spanish, at no cost to development specialists. Topics to date are: Protein sources for swine in the tropics; Alternative feeds for pigs in the tropics; Mammalian coccidiosis; Internal parasites in sheep and goats; Poultry and salmonella; Colostrum for the newborn; Vaccination and the Needle; Diarrhea in young livestock; Stocking rates in the tropics; Facilities for rearing young stock; Feeding the lactating female; Selection and management of replacements; Methods of animal identification; Establishing an artificial insemination service; and Techniques for feeding young ruminants. Their address is 38 Winrock Drive, Morrilton, AR 72110, USA.

WORKING WITH TRADITIONAL HERDERS. H.P. and Nancy Harmon work with people in the Transkei who are traditionally herders and whose first love is animals. Population pressures have forced the people to turn to cultivating the land, much of which is eroding badly.

H. P. wrote that they start with the proposition that it is acceptable to raise livestock. Rather than entice people away from raising livestock, they first work with kinds of livestock that, with careful control, have little negative effect on the environment compared to herds of grazing animals: chickens, ducks, geese, pigs. "After people have these animals and are successful with them, then we are able to talk about the other animals (sheep, goats, cows, horses, donkeys), what is a sustainable stocking ratio, etc.

"We are able to increase farmers' interest in agriculture by having them plant some crops specifically to benefit their animals (e.g. comfrey, leucaena, winter oats). We are also able to talk about planting trees for soil stabilization and nitrogen fixation as side benefits from [their primary concern] for planting trees for forage.

"This is slow work, but we seem to be successful where others have failed because we accept people's right to prefer raising animals to cultivated agriculture. The ironic thing is that having accepted that fact, we now find that their interest in improving their agricultural methods is growing quite fast. I think this is because the benefits also extend to their animals and because they see that we are not trying to replace their animals with cultivated agriculture. ... the environment is slowly being brought back into balance as well. People are raising more small stock, which hardly ever overtax the land, and planting more trees so that the amount of fodder available is constantly increasing."

Feeds and animal nutrition

"FORAGES FOR THE SMALL FARM" TECHNICAL NOTE by Dr. Frank Martin addresses a topic about which we are occasionally asked and with which we have little first-hand experience. Though written with the needs of the small farmer in mind, this document probably best fits the needs of those with more than just a few animals to feed and who farm at least several hectares and perhaps even have some mechanized equipment. It addresses the following: the need for forages on the small farm; site selection; species selection; basic botany of grasses and legumes and the role both play in animal nutrition; the benefits and disadvantages of grazing verses "cut and carry" systems; general principles of forage management; and recommended forages for various sites and purposes. As ECHO carries relatively few forage species, an addenda has been prepared that lists sources for seed and further information. This document is larger than most of the ones we distribute so we ask that only those that really feel their work would benefit from such a document request free copies ($3.50 to those not directly involved in development).

THE SMALL-SCALE MANUFACTURE OF COMPOUND ANIMAL FEED. Stephan von Malortie in Egypt asks: "...my main questions right now are in the field of feeding tables. I am trying to make guidelines for feedcrop use in different areas of the country."

I immediately thought of this book from the Natural Resources Institute. Chapters in this 87-page book include: Economic background to the industry, Nutrient requirements and feed formulation, Feed ingredients: characteristics and supplies, Outline of the feed manufacturing process, and Financial appraisal of small-scale production. These chapters are well-written, short, and to-the-point.

The 40 pages of appendices are especially useful. Appendix 1, Nutrient Specifications, includes detailed tables covering poultry, pig, ruminant, rabbit, and fish feeds. Appendix 2, Feed Formulations lists typical ingredients and proportions for small feed mills in Asia and Africa as well as normal maximum limits to ingredient inclusion. Appendix 3, Composition of raw materials, presents an exhaustive listing of the percentages of various nutrients in a wide variety of possible materials (from barley and buckwheat to spent brewer's yeast and feather meal). Another table lists the typical fatty acid composition of common fats and oils and a table of toxic or undesirable factors in feed ingredients (i.e. velvet bean contains trypsin inhibitors and needs to be heated to avoid problems, shea nut cake contains saponins and should make up no more than 2.5% of a feed). Appendix 4, Feed Processing, has diagrams of typical feed mills, tables comparing motor sizes and capital costs, a table of typical bulk densities of raw materials, etc. Appendix 5, Appraisal of Small-Scale Production Projects has a checklist of information to help decide project feasibility followed by detailed working tables for full financial analysis.

We have already found this publication a great aid in answering technical requests from our network. If your work includes the manufacture of your own animal feeds from locally available materials, this book may be a good addition to your library. Copies are available for £10.00 from: Publications Distribution Office, NRI, Central Ave., Chatham Maritime, Kent ME4 4TB, UK. No charge is made for single copies sent to government, educational, research, and non-profit organizations working in countries eligible for British Government Aid (most developing countries). Use official titles when ordering.

FEED ANALYSES. If you have been mixing your own animal feed rations, you might be interested in Ohio State University's feed analyses, although some knowledge of animal science would be necessary to interpret the results. Dairy feed standard analysis will measure dry matter, total crude protein, phosphorus, potassium, calcium, magnesium, sodium, manganese, iron, copper, zinc, neutral detergent fiber, estimated sulfur, and estimated energy for $21.00. The beef feed analysis ($20.00) is the same except it measures acid detergent fiber and does not estimate energy. Swine feed analysis includes dry matter, total crude protein, potassium, calcium, magnesium, zinc, manganese, copper and iron for $23.00.

Write the Ohio State University; R.E.A.L.; Ohio Agricultural Research and Development Center; Wooster, OH 44691; USA; phone 216/263-3760. Prices quoted were in effect April 1995. Be sure to write them for current prices, detailed instructions on how to take samples, how much to send, etc. before submitting any samples.

USE OF TREES BY LIVESTOCK SERIES. Nick Davison, press officer for the Natural Resources Institute, sent us this new series. The attractive 18-30 page booklets deal with a particular genus of tree (Gliricidia, Erythrina, Calliandra, Ficus, Cassia, Quercus, Acacia, and Prosopis species). One booklet discusses anti-nutritive factors found in trees used as feed. The goal of the series is to bring together the information on selected genera which can increase the fodder supply for ruminants.

The series should be an especially helpful tool for agriculture teachers.

There are 800-900 species of Acacia and 44 species of Prosopis. Looking at them one at a time would be out of the question in the classroom. Considering each as a group, how they differ and what they have in common in terms of livestock feed, is a handy approach.

A few items from the booklet on anti-nutritive factors follows. Hydrogen cyanide is potentially the most serious anti-nutritional factor in fodder trees. Symptoms of cyanide poisoning are labored breathing, intense red conjunctiva (whites of the eyes), frothing at the mouth, bloat, convulsions and a staggering gait. Post-mortem examination often reveals a characteristic smell of almonds from the stomach contents. A full stomach tends to buffer the absorption of cyanide in ruminants, possibly due to its reaction with sugars or sulphur compounds to form harmless compounds. Poisoning is more likely to occur during drought or feed scarcity, when hungry animals consume large amounts of a particular feed over a short period of time. Avoid feeding pods that are wet. Physically separate potentially dangerous feeds from water sources. Cold water appears to encourage the release of cyanide. Mix potentially toxic feeds with sulphur or molasses, or feed them in conjunction with licks that contain these substances.

Do not be too quick to decide that a tree species can or cannot be used for fodder based on a report you read or even your own quick test. "There are many contradictions in the literature regarding the acceptability of fodder from trees and shrubs." Some possible reasons follow. Acceptability can change during the year. For example, milk goats consume more gliricidia when foliage is older with mature leaves. As the growing season progresses, the proportion of mature leaves increases and leads to improved consumption by goats. In some cases it may take several days for animals to accept a new feed, but once accustomed they may consume it readily. Preference for one feed over another does not mean that they will not eat it when it is the only choice. Within a single species, differences can exist between varieties, individual trees and even between parts of the same tree. Acceptability can be influenced by climate and soil conditions. For example, acceptability of the same varieties of Stylosanthes spp. in Australia varies greatly between the sandy, infertile soils of one region and the fertile soils of another.

The booklets are £2 each. Groups working with community development in countries eligible for British aid can request single free copies by writing Publications Distribution Office, NRI, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK.

FORAGES DIFFER GREATLY IN DIGESTIBILITY. As a general rule, tropical forages tend to have more lignin than do temperate forages. The lignin is not only indigestible but also reduces the digestibility of some of the cellulose in the plant. This lower digestibility causes the material the ruminant eats to remain in the rumen for a longer time. The result is that the animal not only is getting less from what it eats but it cannot eat more until the rumen empties. A profitable area of research is developing varieties of forages or introducing new species which give greater yields and have a greater digestibility and a better balance of nutrients. The lushness of a field of tropical grass can be deceiving.

For information or seeds for tropical pastures I most often refer to Better Pastures for the Tropics updated in 1992 by Frank Sauer and Sons, P.O. Box 117, Rockhampton 4700, Queensland, AUSTRALIA. This 77-page, glossy, magazine-size book with many color pictures and line drawings is both attractive and instructive. At A$20 (about US$15), it is still a considerable bargain. Chapters include improving tropical and subtropical pastures, establishing pastures, selecting species and mixes, seed quality, management of improved pastures, pasture grasses, and pasture legumes. They also have sowing guide tables that list rainfall range, seeds per kg, sowing rate, and tolerance to drought, water logging, frost and low fertility. When writing them be sure to ask for their seed price list. I know of no other source for many of these seeds.

A Guide to Better Pastures for the Tropics and Sub-Tropics was first published in 1980. (In May 1995, a new edition is under revision.) The foreword says it "is now well established as an elementary text" on the subject. The chapter titles are similar to the Sauers book, except for one on pasture species for irrigation or high altitude country. It has fewer pictures but appears to have more text and perhaps to cover more plants. For both books and many related, more specific publications, ask for the current booklist from the Tropical Grassland Society of Australia, Inc., c/o CSIRO, 306 Carmody Road, St. Lucia, Queensland 4067, AUSTRALIA. Credit card orders can be made by phone (07-3770209) or fax (07-3713946).

'ALFAGRAZE,' A FORAGE ALFALFA. Many of us know alfalfa as a nutritious, temperate, leguminous, hay crop. We usually do not think of it as a species to be grazed. After 12 years of testing and development, scientists at the University of Georgia have developed the high yielding, grazing tolerant variety called 'Alfagraze'. This cultivar is based on a broad genetic base of 22 cultivars and 1,100 introductions, but was developed for the dual purpose of grazing and hay production for farmers in the States. We do not know how it will do overseas. Dr. Clarence Bryner, a consultant in pasture projects, believes it merits trial and has purchased enough to enable our readers to give it a try. To stand any chance of success at all the pH of your soil must be over 6.5 and you must be able to protect the alfalfa from grazing animals until it reaches full maturity. (After establishment it can be kept grazed to 4 inches/10 cm.) If your work involves peasant farmers, you know the pH of your soil to be over 6.5 and you can protect a trial from grazing, we can send you a small amount of seed.

BUCKWHEAT IS A FAST CROP FOR COOL AREAS. One of the most important questions faced by our readers is how to feed animals when farmers cannot purchase commercial rations. Please write us about your personal experiences in this area so we can share your ideas with the rest of ECHO's network.

John Troesle says that he gets a crop of buckwheat (Fagopyrum esculentum) in about two months in Monte Verde, Costa Rica. They are near the "cloud forest" at something over 3,000 feet (1000 m). Potentially this could give several crops per year. It does best in cool, humid climates and is known for being disease-free. It is an excellent crop for beekeepers too. It is normally grown in northern temperate countries. In parts of Poland and Russia it is a basic item in human diets, but is used mostly for animal feed in the States. However, I had sourdough buckwheat pancakes nearly every morning during winters when I was growing up in Ohio and still love them (although those who did not grow up with them don't seem to like my pancakes as much as I do!).

I asked Dr. Hill at N. C. State University about its usefulness in animal feed. It is not as palatable as most cereals, so should not be used in more than 1/3 of the ration. It is best to grind it for all animals except for poultry, which apparently do well eating it whole. It is a substitute for grain in dairy rations. The nutritional value is about 10-15% less than oats. In the States yields range up to 40 bushels per acre. When used in too high a concentration in pig rations it makes soft pork. This means that fats are too unsaturated and tend to be runny. (Because unsaturated fats are said to be less likely to lead to high cholesterol levels I wonder if pork that is more unsaturated might not be a great thing for human nutrition.) If you are in a region where it is cool and moist, but with no frost, for at least two months, this might be an interesting crop to try.

CAN CITRUS RESIDUE BE USED FOR ANIMAL FEED? Someone in our network asked us this question. The following is abstracted from a University of Florida bulletin "Citrus Feeds for Beef Cattle." Although the bulletin is directed toward cattle, similar results would probably be found with other ruminants. To the best of my knowledge the residues are not fed to monogastric animals such as pigs or chickens, because much of the material would be indigestible.

Dried citrus pulp is high in calcium and digestible energy, but low in digestible protein and phosphorus. (What is the difference between, for example, "digestible" energy and just plain energy? Just because something is present in a food does not mean an animal's digestive system can make use of it. Only the digestible protein is available to an animal; the rest is excreted in the manure.)

When good quality citrus pulp makes up no more than 40% of the ration, and is properly supplemented with protein and phosphorus, it has a feeding value 85-90% of shelled corn. It is highly palatable, i.e. is readily eaten. (We have purchased beef feed containing citrus residue. The smell was wonderful.)

Citrus pulp is classified as a "bulky concentrate feed" because it is a bulky material that is also relatively high in digestible energy. Because it is relatively low in protein (approximately 6%) it is primarily an "energy feedstuff with roughage properties." The bulkiness of citrus residue limits how far it can be transported economically. The volume can be greatly reduced by pelletizing. Its density can be increased from 13 pounds per cubic foot to 42. The reduced volume not only makes transportation less expensive, but also cattle can hold more and might gain a bit faster.

Dried citrus meal (the material that passes through sieves while dried citrus pulp is being made) can be used as a substitute for cottonseed or soybean meal.

The more relevant question for most of our readers, who will not have the facilities to process citrus waste, is the feeding value of fresh wet pulp. It is not widely used today in the States because of the expense of transporting and handling a material containing 70-85% water. Fresh grapefruit was fed routinely by Florida farmers before the dried product became available. Fresh grapefruit is more palatable than orange pulp.

The greater the water content of the pulp the lower the nutritional value. It is basically a carbohydrate (energy) feed, so supplements are necessary. If fed in a feedlot, supplements must include protein, a dry carbohydrate material, a source of roughage, vitamin A and minerals. If fed as a supplement to pasture, it is important to also feed protein and minerals. During the 1940s, several experiments were done on making silage from citrus waste. Including some hay or sugarcane improved the quality and palatability.

IS THERE A BENEFIT TO HAYMAKING? When compared to making hay, much less work is involved if livestock are simply allowed to graze on dead grasses during the dry season. "A major benefit of haymaking is that the nutritional value of green grass hay is substantially better than standing brown grass. Nitrogen content was on the average more than 50% higher in hay, and in vitro dry matter digestibility of hay [Ed: a laboratory test to estimate how much of the material a ruminant animal can digest] was 60% greater in a study conducted by the International Livestock Center for Africa." (Taken from the International Ag-Sieve #6, 1992.)

RAISING PIGS ON MORINGA LEAVES is a system developed by missionary Paul Ronk in Jeremie, Haiti. Some people object to raising pigs because "pigs eat people food" and compete with humans. Paul tested and introduced a new feeding system based on moringa and leucaena leaves.

Every pig in Haiti was killed in 1981 because of the threat of an outbreak of the highly contagious African swine fever. Paul Ronk first went to Haiti to assist the U.S.-supported repopulation efforts which began in 1985. He found that the intensive production systems promoted along with the new pigs taken to Haiti were unsuitable for most Haitian farmers. Farmers were taught to use commercial hog feeds which were not too expensive initially but soon were priced far beyond the reach of small farmers. Paul witnessed many failures in the reintroduction projects due to the lack of adequate feed for the animals.

In 1991, the Ronk family moved to Jeremie in southwest Haiti. There were no pigs in the area when Paul arrived, so he decided to design and test a pig production system appropriate for the Haitian farmers. Before going to Haiti in 1987, he had spent several days at ECHO, and what he learned about trees with nutritious leaves led him to design a leaf-based feeding system which did not compete with humans for food. Four years later, the program has distributed 418 pigs. He estimates that now there are 5000 pigs in an 80-mile radius of Jeremie. Paul says that he must now address transport and marketing.

Regular food supply is critical to the health and successful raising of pigs. Farmers who wish to receive a pig are required to attend two weeks of training in which they learn the leaf-based feeding system, management of the trees, and basic veterinary care for their animal. They take home seeds of moringa (M. oleifera) and leucaena (L. leucocephala) for planting, and in six months an extensionist makes a field check on their farms to make sure the trees have become established. Paul reports that farmers have little trouble maintaining these species in his area. Farmers must have 100 trees each of both species before they receive their pig.

Farmers have a brief refresher course on veterinary care, then return home with a 12-week-old gilt (female pig) which weighs 30-40 pounds (13.6-18 kg). Monthly extension visits are made to each farm. Gilts reach 200 pounds (90.7 kg) in 12-14 months, at which time they are bred to selected boars. Piglets are born in 150 days; these pigs average 7 to a litter, while the world average is 8 and traditional Haitian pigs (before 1981) averaged only 3. The female pick of the litter is taken back to the mission at 8 weeks (about 20 lbs/9 kg), where it is nourished on commercial feeds for 3-4 weeks, until it is given to another farmer and the cycle begins again. Paul mentioned that the few weeks of commercial feed is not necessary, but is just a nutritional boost for the pig.

Moringa has many advantages in this system. Not only is it extremely nutritious and common in the area, it also withstands frequent severe prunings and can be cut short yet out of the reach of goats. Approximately 30 moringa trees, 10 leucaena trees, and a small quantity of other leaves such as banana and yam are needed to support each pig. The optimum diet in this system is about 70% moringa, 10% leucaena, and 20% other leaves. It is possible to feed pigs 100% moringa, but it is important that the diet not contain more than 30% leucaena, as the toxins have negative effects from infertility to death when given in high quantities. (Pigs with leucaena toxicity are identified by hair loss, a malnourished look, and inability to breed. If this happens, feed no more leucaena for 3 months and give high-protein feeds.)

Paul reports that the meat from these pigs is lean and tastes the same as pigs raised on other feeds. He describes the meat of sugarcane-fed hogs as fatty-watery. If sugarcane must be fed to the animals, it needs to be finely chopped-otherwise they expend more energy in chewing than they gain from calories. Dried leaves may make better feed, but Paul has found the drying process too laborious to justify the benefit in his situation. If you have questions for Paul Ronk, write him at Lynx Air International, P.O. Box 407139, Ft. Lauderdale, FL 33340, USA. ECHO will be EXTREMELY interested to learn of your results and/or innovations if you try this system.

NEEM SEED AS A FEED INGREDIENT. As more and more neem trees, Azadirachta indica, are planted in reforestation projects around the world, large quantities of neem seed are becoming available. We have written before of the usefulness of neem oil in making a home-grown spray for insects. Now four Nigerian scientists have shown that the ground seeds can replace up to 28% of the corn and cotton seed meal in a rabbit ration. (The Journal of Applied Rabbit Research, vol. 13, pp 125-126, 1990. We can send a copy of the article upon request.)

Fresh neem fruits were soaked for one day, after which the pulp was removed manually and discarded. The seeds were washed, dried several days, then ground. Four diets were prepared, each calculated to contain 18% protein. Each diet was fed to a set of nine rabbits and statistical studies were made of the results.

	Feed	**Ingredient**	**Diet**	**Composition (%)**
for each set of nine rabbits				
Number of Rabbits	9	9	9	9
Neem Seed Meal	0	10	20	30
CORN	54	45	36	27
Cotton Seed Meal	18	17	16	15
Fish Meal	2	2	2	2
Blood Meal	2	2	2	2
Rice Hulls	20	20	20	20
Bone Meal	1	1	1	1
Limestone	1	1	1	1
Salt	0.5	0.5	0.5	0.5
Vitamin/mineral mx	0.50.5	0.5	0.5	
Total	100	100	100	100
Number of Rabbits	9	9	9	9

Avg. Daily gain(g)	12.1	14.5	11.1	2.14
Avg. Daily Feed Consumption (g)	69	74	74	49
Deaths	0	0	0	3

The statistical analysis showed that the greater daily gain with 10% neem seed meal is statistically significant. The authors speculate that the foul-smelling odor of neem seed meal and bitter taste account for the lesser amount of feed eaten with the highest level of neem.

Note that in these experiments the entire seed was ground. Many farmers might prefer to extract the oil first. This would presumably remove some of the bitter tasting substances. The extracted meal would contain a higher percent of protein, but less energy. Without the oil, the extracted neem seed would presumably more closely resemble the cotton seed meal (meals have had the oil removed) than corn. I would speculate that it could replace cotton seed meal or even soybean meal.

HOW SHOULD I TREAT SOYBEANS SO THEY CAN BE FED TO ANIMALS? Dick Both in Haiti asked us this question. Like many of you, he has found varieties of soybeans that do quite well. They are one of the best sources of protein supplement for animals, a difficult problem on the remote, small farm. Chickens and pigs, for example, are supposed to be fed over 15% protein, yet even a pure corn diet would not go over 10%. Raw soybeans, however, contain a substance called a trypsin inhibitor. It renders the enzyme trypsin incapable of digesting food. This helps protect soybeans from pests, but is a serious nutritional problem.

Commercially, the oil is expelled from soybeans and the meal is heated. The heat destroys the inhibitor. Not many of you will have the equipment to expel oil. I asked Dr. Charles Hill in the Poultry Science Dept. at North Carolina State University for advice. He said that they use an autoclave, heating ground soybeans in about a 1 inch layer for 15 to 20 minutes at 15 psi. He thought that if you could rig up a device to provide steam heat at atmospheric pressure, 30 to 60 minutes would be adequate. It is best to grind the beans first. Dr. Garren at Western Carolina University said he has found that 10% raw soybeans was acceptable in rations for laying hens.

Several of you have asked for a commercial appropriate technology oil expeller. You might want to write to S. P. Engineering Corp., P. O. Box

218, 79/7, Latouche Road, Kanpur, INDIA. (They have several models of "table" oil expellers which were designed for cottage industries. Models require either a 3 or 5 horse power motor.) A source of information about the Sundhara village oil expeller and other designs is FAKT, c/o M. Dietz, R. Metzler, or C. Zarate, Buro Furtwangen, Stephan Blattmann Str. 11, 78120 Furtwangen, GERMANY; fax 49 772 35373.

SUGAR CAN BE USED IN PIG DIETS. I do not know how cost effective this would be, but with the depressed prices of sugar it might be of interest to you. The April 1986 issue of Agricultural Science Digest summarized a report in Australian Agriculture that pigs will grow faster and produce a better quality carcass if they eat plenty of sugar. Sugar was used to replace the cereal content of a normal ration. Pigs were switched to a 75% sugar and 25% soybean, meat and blood meal plus trace elements diet when they weighed 25 kg. Pigs on the sugar diet reached their 80 kg slaughter weight 10 days earlier than those fed conventional rations (710 g weight gain per day compared to 612 g). The carcasses of the sugar-fed pigs was 80% edible compared to a more normal 75% for pigs fed the control diet. The authors point out that because sugar has no fiber content, protein sources that are too high in fiber to be used normally in pig rations can now be used. (The only problem with the low-fiber diet was some diarrhea the first day.)

Bees

BEEKEEPING & DEVELOPMENT, AN "EDN" FOR BEEKEEPERS. This quarterly networking newsletter specializes in information related to all aspects of beekeeping in the tropics and subtropics. A typical issue contains: news briefs related to past, present, and future happenings around the world; practical beekeeping tips, like how to make your own smoker, how to build a hive out of mud bricks and concrete, and queen rearing with African bees. Feature articles deal with case studies and special issues (e.g. tropical trees for beekeepers). Useful bits of information related to job openings, books, meetings and resources of interest to beekeepers in the tropics round out each issue.

One tidbit we recently picked up is how to use a paper clip (with 4 mm inner measurement) as a queen excluder. Newsletter subscriptions (4/year) are £16.00 (US$35). Folks living in developing countries may also pay by beeswax barter or request a sponsored subscription. In addition to the newsletter, they distribute a variety of educational materials, provide free expert advice to those on the field and can assist in project planning and implementation, teaching, organizing seminars, preparing documentation, etc. Write Bees For Development, Troy, Monmouth, NP5 4AB, UK; phone: 44(0) 16007 13648; fax: 44(0) 16007 16167; e-mail 100410.2631@CompuServe.COM.

INDEPENDENT STUDY COURSE ON TROPICAL BEEKEEPING. The University of Guelph publishes many independent study courses on topics in agriculture. The course "Tropical Beekeeping" was written by Dr. Townsend who wrote the article on trees for beekeepers in EDN. It is based on his experiences in directing apiculture programs in Kenya and Sri Lanka and consulting in South and Central America and elsewhere. It details the behavior, management and pests of the African, Asian and Africanized bees, and examines beekeeping in the South Pacific and Caribbean. Processing, marketing, hive designs and protective equipment are also covered. There are 120 color slides on microfiche, a text, a cassette tape and a fiche viewer. The cost is C$70, (about US$50) including surface postage. Write to Independent Study, OAC ACCESS, Univ. of Guelph, Guelph, Ontario N1G 2W1, CANADA; e-mail to request a catalog is handbook@access.uoguelph.ca. They also have an advanced apiculture course for C$225 (Tropical Beekeeping is the last part of the latter).

BEEKEEPING OF THE ASSASSIN BEES/LA ABEJA AFRICANIZADA. (Review by Dr. David Unander.) Since being introduced into Brazil in 1957, African honeybees have been spreading through the tropical and subtropical parts of the Americas. They readily interbreed with the honeybees of European ancestry, so that today it is correct to speak of the honeybees through much of Latin America as being Africanized; that is, most of the wild bees and many of the bees in hives now have at least some African ancestry and behavior traits.

Can Africanized bees be successfully kept, or are they too dangerous? The newspaper where I live, normally not overly hysterical, once devoted the cover story of its Sunday magazine to predictions of great personal danger to citizens and grave economic loss to farmers as the "killer bees" begin to arrive in California. Dr. Dario Espina- Perez, a Latin American entomologist and beekeeper, disagrees strongly with this B-movie scenario in his excellent book.

He begins with a very interesting chapter on tropical apiculture (beekeeping) per se. He discusses, for example, problems with heat, humidity, termites and dry seasons; various options for hive construction; how to move established wild colonies from undesired places, such as the eave of a house, to a hive; evaluating the apiculture potential of a region; and problems from agricultural insecticides. A chapter on African honeybees describes in what ways they differ from their European cousins. In particular, they are smaller, tend to swarm more often, are more aggressive and seem to produce 50-100% more honey.

He carefully makes the point that all bees are aggressive some of the time. The aggression of Africanized bees has been found to vary with region and altitude. The higher the altitude, for example, the more pacific their behavior becomes. (I hope this is good news for some of you living in mountainous areas). Like all honeybees, they are most aggressive when they perceive their hive as being threatened, and least aggressive when collecting pollen (unless directly stepped on). There is a chapter on bee aggression; how it is regulated in the hive, how a stinger works, different human reactions to the venom, including allergic reactions and, of great value, a list of medications to have on hand for various numbers of stings and reactions to them.

After this foundation, there are four chapters with recommended management techniques for Africanized bees organized under: (a) controlling aggression, (b) controlling swarming, (c) controlling migration, and (d) miscellaneous tips. He has a well-developed plan for maintaining breeding colonies of both European-ancestry and local Africanized bees, with hives for honey production using hybrid bees. There is a good discussion of where to place-and where not to place-Africanized hives. For example, Africanized bees do not like vibrations from highways nor strong smells of any origin near the hive. Also there is a review of necessary bee-keeping equipment. I learned that Africanized bees react most negatively to dark colors, better to white, and best of all to orange. There are various recommendations for hive dimensions and openings, honey harvesting schedules, keeping track of new queens, and other management techniques, in order to control the swarming and migratory tendencies of these bees.

Additional ideas are contained in five appendices. There are also some pages of references. One appendix contains the minutes from a question and answer session between Honduran beekeepers and a round table of entomologists and beekeepers experienced with Africanized bees, followed by detailed recommendations for Honduras beekeepers which were worked out at that meeting.

Excellent diagrams and photos illustrate successful apiculture operations with Africanized bees by various Latin American beekeepers. There are also photos of hive structures he advises against. Although the Africanized bees are not the "killer bees" of Hollywood, it seems clear that their aggression merits enough respect that some low- cost apiculture techniques which were previously acceptable in the Americas are no longer safe; beekeeping will now need greater forethought and some additional equipment.

La Abeja Africanizada by Daro Espina P., 158 pp., US$4; or Beekeeping of the Assassin Bees, 170 pp., US$6 are published by Instituto Technolgico de Costa Rica, Editorial Technolgica de Costa Rica, Apartado 159-7050, Cartago, COSTA RICA. If you are a beekeeper in the Americas, it would be a good investment.

Dr. Hal Reed, an entomologist at Oral Roberts University, wrote, "The review states that the Africanized bees readily interbreed with honey bees of European ancestry. This is not entirely correct. Recent evidence published in Nature and discussed at the recent National Entomology meeting indicate that very little interbreeding is taking place between the European and African strains. Indeed, researchers feel that the leading edge of the invasive population in Mexico is almost purely African, like the original bees introduced in Brazil. There is disagreement about the degree, if any, of interbreeding."

Dave Unander wrote, "Debate continues among scientists regarding the extent to which the African bees are hybridizing with European bees as they migrate northward. (All honeybees in the Americas are believed to have been introductions since Columbus.) If there is substantial mixing of the populations, it is hoped that the undesired behavioral traits of the African bees, such as aggressiveness, might be modified. At this time evidence seems to suggest that bees of purely African ancestry out-compete the hybrid African-European bees. Several prominent bee scientists believe they have data, however, suggesting that the advancing bees are hybrids. Whether they are or not, they so far do not seem to be changing their behavior. So all of the changes in beekeeping methods recommended by Dr. Espina continue to be relevant. As of the summer of 1991, African bees have entered the United States and are expected to ultimately establish themselves from throughout the southern USA to the temperate region of Argentina."

IS THE NEEM TREE HARMFUL TO HONEYBEES? Dave Morneau in the

Central Plateau of Haiti asked us about the Haitian beekeepers' belief that neem (Azadirachta indica) or chinaberry (Melia azedarach) blossom nectar is harmful to honeybees, since leaves and seeds are widely used to control insects. We checked ECHO's library and found no written evidence to support this concern.

Neem: A Tree for Solving Global Problems reports that neem is benign to most beneficial insects, and "[insects] that feed on nectar or other insects rarely contact significant concentrations of neem products." The authors cite a study which found that "only after repeated spraying of highly concentrated neem products onto plants in flower were worker bees at all affected. Under these extreme conditions, the workers carried contaminated pollen or nectar to the hives and fed it to the brood. Small hives then showed insect-growth-regulating effects; however, medium-sized and large bee populations were unaffected."

Beekeeping in India mentions that neem is an erratic producer of nectar, but that the chinaberry does not seem to be visited by bees. Another source lists neem in its list of common nectar sources for Sri Lanka, flowering in May and June. A table in Agroforestry in Dryland Africa shows that providing fodder for bees is a major use of neem and a secondary use of chinaberry. Finally, the thorough Handbook of Plants with Pest-Control Properties does not include either neem or chinaberry in its group of plants which are toxic to honeybees. A visitor from India told us that bees are used to pollinate the extensive neem orchards in his area. Based on our research, we cannot confirm the Haitian farmers' concern that neem could harm their beehives.

Dr. Nicola Bradbear with Bees for Development responded to this article. "Here at Bees for Development we have never received information that either [neem or chinaberry] is harmful to bees. On the contrary, both are frequently cited as excellent sources of pollen and nectar for honeybees (see for example Honeybee Flora of Ethiopia pp. 340-345). It would not be in the interest of flowering plants to produce pollen and nectar that are toxic to possible pollinating insects. ...In Beekeeping and Development 27 we carried news of research in India which indicated that [spraying with] neem derivatives did not deter three bee species from visiting coconut spathes having receptive female flowers with nectar. However the research did not indicate whether the derivatives were toxic to the bees."

WHEN HONEYBEES BECOME DRUNK. According to the October 1992 issue of Apis, drunk bees can be a problem. An Australian scientist studying beekeeping practices in Kenya observed strange behavior. Drunk bees had difficulty coordinating their actions. They may die or be unable to return to their hive. When they do make it to the entrance, strange acting drunk bees are rejected by the guard bees. Finally, drunk bees are more vulnerable to predators.

Apparently local beekeepers were feeding hives weak sugar solutions, which often fermented. Fermentation of weak sugar syrup can be avoided by feeding bees stronger solutions and/or ensuring that the sugar water is consumed quickly. "Because many beekeepers do feed sugar syrup during marginal times, this brings into focus another possible reason colonies might suffer either autumn collapse or spring decline in population."

HOW DO THE AFRICANS HANDLE AFRICAN BEES? I know of folks in the Americas who are giving up beekeeping because of problems that arose when the African bees migrated into their areas. On the other hand, a beekeeper told me of a government project that was proposed to some farmers in Argentina some time ago to supposedly get rid of the African bees there. The beekeepers were not interested because of the higher yields of honey with the African bees. Our readers in Africa work with these bees all the time, so I wrote to Neal Eash in Botswana and asked if he could recommend a practical beekeeping guide for handling African bees. He sent us an excellent book called the "Beekeeping Handbook." You can order it from the Beekeeping Officer, Dept. of Field Services, Ministry of Agriculture, Private Bag 003, Gaborone, BOTSWANA, Southern Africa. You can order them for $2 each, postage paid by surface mail. There is a discount price of $1.50 for 10 or more books.

I think you will find this basic 76-page book to be an excellent and practical guide. It is especially surprising to see pictures of men and boys wearing short-sleeved shirts and shorts handling the African bees. Neal wrote, "My father kept bees. I remember putting on coveralls and heavy gloves, tying pant legs and shirt sleeves and we still got stung. It took a little courage here the first time I worked with bees in a pair of shorts, a T-shirt and straw hat, but I rarely get stung by this so-called 'vicious' bee anymore." He did mention that he recently was stung 7 times when a frame broke just as he ran out of smoke. The Heifer Project Exchange says the book can also be ordered from International Bee Research Assoc., Hill House, Gerrards Cross, Bucks SL9 ONR, ENGLAND.

ONE EXPERIENCE WITH BEES IN AFRICA. Herb Perry gave us this report of an experience with bees while at the Mt. Silinda Mission in southeastern Zimbabwe, located in a subtropical rain forest at 1500m elevation. "One day on returning to my home in a car, I found a large group of African children along with my own children inside the house where my wife was busy extracting bees from the children's hair. It seems they were all playing outside when suddenly the bees attacked and the children all ran screaming into the house. Once inside my wife took to dunking the children's heads in basins of water in an effort to remove the bees from the hair in which they were lodged. This seemed to work, but of course the bees' stingers remained in the scalp and the bees soon died. For about half an hour in the vicinity of our home, nothing moved without being attacked by an angry horde. After things had quieted down somewhat I ventured outside to survey the area. We had a flock of chickens, and they were all dead. We also had a cat which had recently produced a litter of kittens. The mother cat had disappeared into the forest, but the kittens were all dead. The mother returned eventually, but had been stung repeatedly all over her head. Our dog suffered the same fate. He also sought refuge in the forest, and also returned with many stings on his face. Laundry that had been hung on a line to dry, and which had blown in the breeze, had also been stung. The bees appeared to attack anything that moved. We can only guess at what made them become so ferociously hostile, but it has been suggested that perhaps a chicken had eaten one, or someone had carelessly swatted one. At any rate it was a terrifying experience for everyone, especially the children and the animals.

"In spite of the perils involved, many African families would harvest the honey from these wild bees whose hives were generally to be found in hollow trees in the forest. The honey was always very dark, very much like molasses in appearance. Generally speaking the honey would be gathered during the early morning or late afternoon, suggesting perhaps that the bees are inclined to be more docile during these periods."

STOPPING BEES. Suppose a situation arises where you must quickly eliminate an exposed group of bees. For example, a swarm is hanging in a school yard or a truck carrying hives has upset. How can you kill or immobilize the bees?

Dr. Eric Mussen, a California extension bee keeper, writes in his newsletter From the U.C. Apiaries, "The answer in many cases, especially in areas of Africanized bees, is 'soap water.' Mix one cup of dish washing detergent in a gallon of water and apply to the swarm using any sprayer. He says it is just as effective as using a flame thrower.

Dr. Mussen believes this works because detergents are "wetting agents." This means that water sticks to every surface of the bee instead of running off. The bees are unable to fly with wet wings [and perhaps heavier body weight when wet?]. The spiracles, or breathing holes, which normally are able to repel water, are entered by the "wetter" water, suffocating the bee.

Do not use it near a hive where it might get on the comb, if you want the hive to return to normal activity. [The above is based on an article in Apis, the state of Florida beekeepers' newsletter.]

Camels

INTRODUCING THE CAMEL, by Peter Grill. Lamar Witmer in Kenya sent us a copy of this unique book. He wrote, "I've read a number of books about camels. The one I am sending you is the one I believe to be the most useful as a single guide for development workers among pastoralists who herd camels. It emphasizes practical concerns rather than purely scientific ones. It was written from the perspective of eastern

Africa, which may limit its usefulness in other regions.

"One of the problems is that it was printed by special project money in 1987 and only a limited supply remains." Well, we agreed that it was a practical and unique book that should be easily available. So it was reprinted by the Mennonite Central Committee Office in the USA for distribution by ECHO.

It is a 149-page, spiral bound book. Chapter titles include: habitat of camels; camel adaptations to heat stress; reproduction (reproductive habits, rutting behavior, signs of oestrus, oestrus cycle, coitus, pregnancy testing, parturition); raising camel calves; establishing a camel breeding herd; products from the camel (milk production, composition and products, meat, blood, hides and wool, misc.); the riding camel (uses, selecting, pace, selecting by age, training, handling, weight bearing, breaking the lead, riding saddle), camels as beasts of burden (potential uses, capacity, age for training, moving a camel train, loading a camel, types of baggage saddles, making a baggage saddle, draft camels, plowing with the camel, other uses as a power source); buying camels (marketing system, difficulties, selecting, determining the age); feeding and watering camels (eating habits, feeding management, watering, drinking rate); common camel health problems in Kenya (general health, signs of a sick camel, examining the camel, common health problems, diseases [protozoal, bacterial, viral, internal parasites, external parasites, other problems]); developing a record system.

An excerpt from the feeding chapter follows. "Camels are primarily browsers. This gives them an advantage over cattle because they will eat leaves from trees in addition to grass much more readily than cattle will. ... [This] makes them ideal animals to add to the livestock mix of commercial ranches. Some ranchers in Kenya have added camels to their cattle and small stock ranching system so that they can use the camels to open up new pasture areas for the small stock. In dense brush the camels are brought in to browse the bushes. This breaks up some of the dense brush so that the goats can come in and browse the lower branches. The goats thin out the foliage so that the sun can reach the grasses. The additional sunlight increases the growth of the grass so that the cattle and sheep have more to eat. ... they increase the carrying capacity of the land for cattle and sheep in addition to the meat and milk from camels who are eating what would normally be unused by the other stock." Available from ECHO for $5 plus postage.

Cavies

TECHNICAL NOTE "MEAT PRODUCTION ON THE SMALL FARM WITH CAVY (GUINEA PIG)" by Dr. Frank Martin, 6 pages. The cavy is a rodent that was domesticated in the Andes as a source of meat. Because it is small, it can be eaten by a small family in one meal and does not require refrigeration. The meat is much like that of a rabbit, with low fat content. The cavy multiplies rapidly, though not at the rate that folk literature would suggest. With breeding as recommended in the technical note, one pair might produce 260 new pairs in 2 years. The wide variety of foods that the cavy will eat is a benefit. In parts of Latin America, cavy breeds much larger than those common in the United States are used. Request the note from ECHO.

Chickens

IMPROVING BACKYARD CHICKEN PRODUCTION. "Probably more people are directly involved in chicken production throughout the world than in any other single agricultural enterprise," according to Dr. John Bishop, a poultry specialist who has worked extensively in Latin America and Africa to improve the production of traditional small-farm poultry. Maintaining and improving the productivity of backyard chicken flocks is important for the well-being of rural families.

Backyard producers value chickens for their adaptability, contributions to the family's income and nutrition, and for insect control and fertilizers in the garden. In most family flocks, chickens scavenge plant or food residues and insects around the home. With minimal care, they can hatch and raise chicks, produce high-value meat, and give eggs which meet a strategic nutritional need of children. Live chickens sold for meat bring a good price and are a primary source of household income. (This is why "new" fowl are not always quick to catch on in village settings: farmers raise chickens because they sell easily in markets- not primarily for home use or egg production-and it would be harder to sell more unusual birds.)

"The efficiency of backyard animal production lies in the fact that it utilizes excess family labor and surplus on-farm feed" with few purchased inputs, so income from sale of the chickens is virtually all profit. High-input, large-scale poultry systems are obviously not suitable for family flocks, and even "transitional" systems of 200-300 birds which apply large-scale technologies (such as hatchery breeds, balanced feeds, and artificial lighting and brooding) to small farms are rarely successful.

It is extremely difficult for families to maintain flock numbers and replace birds which are lost or sold if they cannot produce chicks on their farm. Buying replacement chicks from a hatchery is expensive and can be disastrous for household chicken production. Hatchery birds may require artificial incubation, disease control measures, or special feeds not available on the small farm. All these effects are serious for the farm family, but the loss of hens' broodiness (readiness to set on eggs for hatching) is particularly serious.

When hatchery roosters cross with traditional hens, flocks can lose their ability to hatch and raise chicks in just one generation. In Ecuador, for example, the commercial hatcheries surrounding the cities may "dump" their extra birds (mostly roosters) in rural areas at low prices. While traditional ('criollo') hens are selected for broodiness, superior egg-laying hatchery varieties are not broody or show only incomplete broodiness, such as laying eggs but not setting consistently. This can quickly make the farmer dependent on buying incubated hatchery stock, which may not perform well in backyard conditions. People who substitute them for criollo birds may have little success with incubator hatching methods in areas of erratic electricity.

Farmers who have encountered this problem learn quickly. Dr. Bishop told of a worker in the Amazonian region of Ecuador who was improving a flock to share with local indigenous farmers. When the farmers saw one white bird they said, "We don't want to contaminate our flocks." They then told how a specialist gave them "superior" white roosters, and they had to get rid of their flocks and start over with chickens from tribes that had not participated. Broodiness is a key link in the small-scale poultry production system, since the producer sells hens, not eggs. Of criollo birds in a backyard management situation, only one third of a flock usually lay each day; one third laid the day before, and the other third are setting or caring for chicks.

Dr. Bishop suggested that development projects make it their policy to avoid dealing in hatchery birds (even traditional breeds like Rhode Island Reds have lost most of their ability to successfully hatch eggs) and purchased feeds. He named the following key elements for economically viable family poultry production. (1) Use small-scale production systems with low purchased inputs and minimized risk. (2) Choose appropriate breeding stock which can incubate and brood replacement chicks by natural reproduction. (3) Apply the fundamental pest and disease control practices outlined below.

Basic, inexpensive disease control markedly increases the survival and productivity of a family flock. Traditional chickens that are vaccinated and treated for common infections and parasites are usually hardy enough to thrive in backyard conditions. The following four preventive practices, given every three months, will eliminate most health problems in poultry flocks: vaccination in the eye for the Newcastle disease virus (which is highly infectious and can kill the whole flock), deworming for roundworms and tapeworms, dusting under wings for irritating external parasites such as lice, and treatment for chronic respiratory disease which lowers production.

As for nutrition, the main limiting factor in traditional production is inadequate energy in the feed available to backyard birds. Scavenging chickens can usually fulfill their protein, vitamin, and mineral requirements, but are unable to obtain sufficient energy for adequate growth and egg production. Small amounts of supplemental grains such as corn can yield impressive results in weight gain and egg production. It is often more profitable to convert surplus grain into eggs and birds for sale than to sell the grain directly, since in many areas a chicken sells for more than a whole sack of corn.

Consider a permanent flock stabilized at 12 adult hens and one rooster. The farmer could let one broody hen set per month with 10-12 eggs and thus produce at least 4 replacement chicks per month, after losses in incubation and brooding. A hen takes about 4 months to raise her chicks, so at any given time about 4 of the 12 permanent hens would be caring for chicks, leaving the other 8 hens for egg laying. Without supplemental energy feed, the farmer would probably only get 2 eggs per day. By feeding the twelve hens one pound of corn per day, the 8 laying hens will give an average of 4 eggs per day. This system would produce 4 replacement chicks and about 10 dozen eggs per month. For the farmer, the broody hens likely earn more by raising 4 chickens for sale than the value of 4 months of eggs.

Dr. Bishop says that where the traditional flocks have disappeared or are being eroded, it is necessary to establish multiplier flocks of appropriate breeding stock which can naturally incubate and brood replacement chicks. He has a foundation breeder flock in Ohio of "Triple Production Reds" (meat, eggs, and chicks), and can provide a limited supply of hatching eggs for a starter multiplier flock. He is the founding director of the nonprofit ministry Poultry Development Service, 11806 SR 347, Marysville, OH 43040; tel: 513/348-2344. For more information on this subject and details on the disease control measures, write to ECHO for Dr. Bishop's Technical Note "Chickens: Backyard Production in the Humid Tropics." To inquire about receiving hatching eggs, contact Dr. Bishop directly.

Fish

DRY FISHPONDS BECOME OASES OF PRODUCTIVITY. (Excerpted from Spore August 1994, p. 12.) "Fishponds are a relatively new innovation for farmers in Malawi. ... [During the 1992 drought] farmers with fishponds were able to harvest the fish before the ponds dried out. ... the farmers were then able to plant vegetables in the pond. This gave them an extra crop when other farmers were unable to grow anything."

AUBURN UNIVERSITY IS EXCEPTIONALLY SUPPORTIVE OF PVO WORK IN AQUACULTURE. I spent a stimulating week at Auburn University's International Aquaculture Program. I have never seen such a concentration of both faculty and graduate students who were eager for opportunities to help private voluntary organizations (PVO's) with aquaculture problems and opportunities! Auburn will assist you with technical information, ideas from their development experiences, and even "tailoring" training for visitors or requesters.

They offer an annual eight-week aquaculture training program (in 1995 it was July-September). The comprehensive course is designed for fisheries technicians and administrators, as well as for those who practice aquaculture with PVOs. The emphasis is on practical experience and techniques appropriate for developing countries. Cost in 1995 was $4000 plus living expenses. Write to ATP Coordinator, Department of Fisheries and Allied Aquacultures, Auburn University, AL 36849-5419 USA; phone 205/844-4786; fax 205/844-9208. If you are looking for staff with expertise in this area, you may also want to mention your need to Dr. Bryan Duncan of the International Center for Aquaculture at Auburn University; he may be able to refer some graduate students to assist you in your project.

CONSULTING HELP IN WATER RESOURCE MANAGEMENT, FISHERIES AND AQUACULTURE. The Auburn University staff are exceptionally knowledgeable about third world applications in these areas and have been ready to help with technical information.

Living Water International (LWI) started with Auburn scientists. Dr.

Bryan Duncan writes that LWI "is an association of specialists in water resource management, fisheries and aquaculture. LWI was founded to provide information and technical assistance to Christian missions, and similar humanitarian organizations with limited resources working in developing countries. LWI associates hold graduate degrees in their specialties, and are experienced in working and living internationally.

"Specialists are qualified in the following: aquacultural production; freshwater capture fisheries; aquatic ecology and environmental assessment; site assessment and design of aquacultural facilities; harvesting and storage of surface water for multiple use; water quality; integration of agriculture and aquaculture; project feasibility, design, implementation and evaluation; education and training.

"LWI provides services, rather than funding, to other organizations. LWI may be approached directly by organizations desiring assistance, and a response will be tailored where possible to meet the needs and resources of the requesting organization. Write Living Water International, 805 Cary Drive, Auburn, AL 36830, USA."

NEW BULLETIN SERIES: WATER HARVESTING AND AQUACULTURE FOR

RURAL DEVELOPMENT. The Water Harvesting/Aquaculture Project (WH/AP) at Auburn University has designed this new series primarily for development workers and extensionists with little or no prior experience in the area. The booklets are very practical with a writing style that is easy to read and not overly technical (about half the information is presented in diagrams and illustrations). All are available in English, French, and Spanish.

The series contains 20 booklets so far. General manuals include: Transporting fish, Feeding your fish, Intro. to water harvesting, Eliminating unwanted fish and harmful insects from fish ponds, Intro. to polyculture of fish, Intro. to fish culture in ponds, Intro. to aquaculture, Fish culture in rice paddies, and Intro. to intensive cage culture of warmwater fish. Fertilization manuals are: Intro. to fish pond fertilization and Chemical/Organic fertilizers for fish ponds. Tilapia manuals include: Intro. to Tilapia, Reproductive biology of Oreochromis niloticus, Intro. to Oreochromis niloticus fry and fingerling production systems, Net enclosure system for Oreochromis niloticus fry and fingerling production, Production of mixed-sex Oreochromis niloticus fingerlings in earthen ponds, Culture of hand-sexed male tilapia, Single pond system for sustainable production of Oreochromis niloticus, and Oreochromis niloticus production in tanks.

We will share one helpful hint mentioned in the manual "Transporting fish." A key to success is, of course, to have plenty of oxygen in the container. If it is necessary to have very many fish in the transporting container, or if the trip is unusually long, the oxygen added at the pickup point (if any) may become exhausted. But if you can purchase hydrogen peroxide, which is widely available around the world in pharmacies, you can actually generate oxygen.

Dip a 2 liter plastic bag (26 x 26 cm) in clean water several times to get it wet, then shake to remove excess water. Place 1 gram of fish liver in the bag then crush it by hand. Add 40 ml of 6% by weight hydrogen peroxide, then quickly expel all the air and seal the bag with an elastic band and shake it. Within 5 minutes the bag will be filled with oxygen. Use a tube to connect the oxygen bag with the transport bag and squeeze to transfer the oxygen. Do not squeeze liquid from the oxygen bag as it may kill fish. If the transport bag is not completely filled, use a tire pump to finish filling it.

If none of this is possible, you should at least periodically bubble air through the container using a tire pump.

WH/AP intends to continue the series with new booklets being published and old ones updated as long as funding allows. Brochures are free of charge, although you may be charged for postage. (Specify language preference.) The brochures are also available on floppy disk in MacIntosh format. They ask that development workers interested in obtaining copies have their field office write, listing the particular titles wanted, to Dr. Bryan Duncan, International Center for Aquaculture, Auburn University, AL 36849-5419, USA.

HOW TO GROW FISH IN THE MOUNTAINS is by Joe Richter, a missionary-biologist with FARMS in the Philippines. He wrote this book for the farmer and has done a good job of keeping it simple yet covering a great deal of practical information. Every one of its 37 pages is illustrated with one or more drawings. Topics covered are: why grow fish; common cultured fish; pond construction; fingerlings and their production; sexing brood fish; predators; fertilizing and feeding; integrated fish farming; harvesting; and common mistakes in growing fish. You may order the book from ECHO ($5 including postage). Here are some excerpts.

A simple test will determine if your pond site will hold water. "Dig several holes, a bit deeper than your intended pond bottom. Fill with water and observe. If the water still disappears after several fillings, the site may not be suitable for a pond. But if the water remains in the holes the soil is suitable for a pond." Because of the danger of theft, "submerged wire firmly staked into the pond bottom will hinder fishing and netting. Barbed wire may be necessary." Are all fingerlings of good quality? "No! ...inbreeding (breeding between relatives) will produce poor quality fingerlings. In-breeding is a problem in using fingerlings from your own pond, because some of your original stock will be related to each other. [Avoid] stunted fingerlings, fish that may be several months old but still are very small due to lack of food in the pond they came from. They may be already sexually mature and will quickly reproduce and fill your pond with unwanted fingerlings. These stunted fish will grow very slowly." Farmers in the mountains should produce their own fingerlings. "You will need a 1/2 meter deep brood pond that is easy to net and to drain. Initial brood fish need to come from a reliable hatchery. Stock one male for every three females. Stock at a rate of 200 kilograms of brood fish per hectare (e.g. 40 fish weighing 50 grams in 100 square meters)."

"For every kilogram of fish in your pond you can add 80-160 grams of wet manure daily. If your manure is dry, add only 20-40 grams." "Sunny days are best for manure application. The morning is the best time to manure, so the nutrients can be used during the sunny part of the day. Afternoon application can cause a loss of oxygen during the night which can kill the fish." "How do I know when I am fertilizing enough? An easy test is to bend over and place your hand under the water. If your hand disappears before your elbow reaches the water, the pond has enough fertilizer. You should never be able to see the pond bottom." "Carp will eat some of your fingerlings and may allow your tilapia to grow to a larger size."

THE INSTITUTE OF AQUACULTURE at the University of Stirling, Scotland, is a resource center which concentrates on nutrition, reproduction and genetics, disease, and environmental studies in aquaculture. They offer many (commercial) consultancy services. The Institute offers studies through the doctoral level, as well as several short courses. You may inquire about their publications and services at: Institute of Aquaculture, University of Stirling, Stirling FK9 4LA, Scotland, UK.

Muscovies

MUSCOVY DUCKS FOR DEVELOPMENT PROJECTS IN THE TROPICS. We mentioned that both Frank Martin with the USDA and Fred Harder with the Heifer Project had told us that for really efficient meat production in the tropics we should be looking at Muscovy ducks. I asked if any of our readers could help us out from their own experience. We received some interesting replies.

Fremont Reiger in Botswana wrote, "Along with our rabbits and a few laying hens, we kept quite a few Muscovy ducks in Zaire. We had duck as our favorite Sunday dinner. We found them much more hardy than chickens-once you got them past the early few days. As hatchlings they were very susceptible to drowning in waterers, rain, getting killed by predators, etc. But once they were a week or two old, they were almost disease free, and grew very rapidly. We fed them chicken mash and often had a hen and her new brood on grass in a false bottom pen/house combination that we moved each day over new grazing grass. I have seen Muscovy ducks in many countries under varied conditions. They seem to thrive everywhere. Taboos against duck meat were a problem in Zaire with some groups. Fencing is easy because ducks normally require a quite low fence. An occasional one may take off and end up outside the pen. We had to build some small pens to keep drakes away from new ducklings, for they would kill them. They do not need water to swim in, but need lots of water to drink, which they dirty quickly by mixing feed in their water. Setting hens also need water to wet their feathers to maintain incubation humidity conditions."

Cheryl Campbell wrote from Zaire. "I have had good success with Muscovies. Unlike rabbits, cattle, goats and local chickens, the ducks need no veterinary products or special feed requirements. Where we work we can never count on medicines or feed supplements. Muscovies like water but survive well on only a dish pan full. They breed readily on land and are not as well equipped for swimming as are other ducks. There is no need to make a pond for them. They are better foragers than most ducks. Here in the village they survive quite well on foraging only. They take much less care than rabbits.

"They come in various colors. Ours are black and white. The Africans think the black ones are less susceptible to hawks. We started with one male and two female adults. After 8 months we have had about 25 eggs to eat and 45 ducks of various sizes to eat. We had losses from drakes killing ducklings until we separated them. You must keep the ducklings out of the rain and tall wet grass. I keep them penned up in the rabbit house at night. In fact, I raise the ducks with rabbits because they clean up all the feed that the rabbits spill. Make sure that the feeder and waterer are close together and that the waterer is shallow enough that they cannot get trapped in it and drown. I use a basin with a small log in it so they can get out. They need to have enough water to keep their noses clean. Feeding can be just a nice lawn if you don't mind them wandering. They usually will return to their pen before dark. They eat insects and grass enough to keep them healthy. I supplement my older ducks with manioc flour mixed with very little millet and corn. Or I feed millet if I have a lot. They can survive from scavenging around the yard, but grow very slowly. When I can feed them a high protein ration with soybean flour or dried fish in a millet base during the first 2-3 weeks, they grow much faster.

"Nesting boxes need not be fancy, just a corner in a dry place. No floor or ceiling is needed: let them nest on the ground-fowl eggs often need the extra moisture. Provide some dry grass or straw for nesting material, then partition them from any disturbances in a 3-sided box. They lay about 9-16 eggs, then set for 33-35 days.

"Spacing in the pens is important because too many ducks can result in cannibalism. You will know when there are too many because there is a definite pecking order, with the youngest the most affected. After 3 age groups were put together we noticed the fourth group was not well accepted. So we put all the older ducks in a new pen and start to fill the old one again. Once they are old enough to defend themselves we can add them to the older ducks. Drakes especially tend to fight more if they are crowded. In other words, it is nice to have an extra pen."

Geoff Clerke in Papua New Guinea sent us a good 8-page mimeographed article called "Muscovy Ducks for PNG Villages." (We can send you a copy of this upon request.) Here are a few highlights. The Muscovy is ideally suited for PNG village conditions where farmers rely on natural incubation and foraging. You need good shade, because the ducks may get sick if they stay in the sun for long. Do not put them near a pig fence because hogs kill and eat ducks. If possible, feed commercial feed for 6 weeks. A duckling will eat about 3 kg. In the highlands you might need a brooder for extra heat for the first two weeks. To do this, make a small round enclosure about 1 m in diameter with flat iron, woven bamboo, cardboard, etc. and cover it with old bags, leaving an uncovered strip about 30 cm wide in the middle. Put a kerosene lamp inside the strip not covered by the bags.

After 6 weeks, ducks can be fed entirely on locally produced food: sweet potatoes, taro, banana, pumpkin, choko, etc. Ducks will eat anything that humans eat, but their food must be cooked. Follow this rule to know how much feed to give them: If they eat everything within half an hour they are still hungry; cook more the next time. If they start to wander away from the feed after half an hour and some is left, they have had enough. Feeding locally-produced feed is not enough. They must be able to graze/forage daily in order to get enough protein, mainly from insects and grass seeds which are not found on bare ground or in short grass. Even a very big fence is not enough because as soon as all the grass is finished it will become bare and hard from grazing and trampling. There must be no fence around a duck house: a fenced-in project is a project that will fail. It is better to have a few ducks lost to dogs or other predators than to have the whole flock dying due to protein deficiency. Lack of protein will result in poor growth, never getting heavy enough to eat. Also, lack of feathers will let them get cold and die. Finally, they will never lay eggs.

In selecting breeding stock, choose the heaviest drake with a belly parallel to the ground. Do not keep any drake which looks like it is standing with the breast much higher than the belly. Do not keep more than 10 ducks for breeding; otherwise, it is probable that the garden produce will be in short supply to feed the flock and all the birds will do poorly. Hens can be kept for 3 years and drakes 2. Ducks start to lay at 8 and 1/2 to 9 months. The first eggs are small and should not be used for hatching, as they are likely to be either sterile or to give small and weak birds. If a duck does not lay eggs, it should be eaten or sold. It can be recognized because (1) it is heavier than the other birds, (2) the flesh around the eyes is red, like a drake, instead of being pink or orange, (3) the space between the two pelvic bones is about 1 finger wide instead of 2 or 3. Eat or sell ducks at 4 months unless they are to become breeding stock. [There is much more practical information like this in the PNG write- up.]

ECHO no longer has Muscovies. We found that muscovies would periodically swing through planting areas eating young vegetables. We fenced in the pond and clipped their wings to keep them in, but then predators killed most of them. When our local bobcat problem is not too serious, we maintain a flock of Khaki Campbell ducks, known for their egg-laying. Ducks are hardy, low-maintenance animals, suited for flooded areas in the tropics where chickens or other animals may not thrive.

Where can you obtain muscovy ducks? Try to obtain ducks in your own country. If this is difficult, you might ask Heifer Project (see above) for help in locating a source; they may know of one near you. Dr. Jim DeVries at Heifer Project said that Muscovy ducklings are especially difficult to ship, even in the States. If they do not receive special care within 48 hours, the losses will be high. It would probably be best to ship eggs, but they are very difficult to hatch in an incubator. He recommended that you hatch them under a chicken or duck.

Rabbits

INSIGHTS ON RAISING RABBITS IN THE TROPICS. I have talked with some development workers who have been very positive about the role of rabbits in their work. Others have been equally negative. Fremont Regier has worked for some time in Zaire and now in Botswana. He was recommended to me as one who is both successful and enthusiastic about rabbits. So I wrote and asked him why rabbits catch on with one person/place and fail with another. He not only sent a thoughtful reply to this question but included a write-up for volunteers called "Some planning ideas to remember when considering rabbit production as a church project." We will be happy to send you a copy of all of this upon request. Here are some highlights summarized for you.

"In questioning many one-time rabbit raisers who later abandoned the work, I got many reasons why they stopped. Some said their rabbits died, others that they couldn't sell them, or that they had no food. In questioning other raisers who had continued to raise rabbits, I was told that rabbits do not die for no reason (hunger or ill care of dirty cages cause it), that these people had no trouble selling any rabbits they had and that feed was available. I surmised that in many cases it boils down to the fact that it just takes too much time and work for some people. Not that this is necessarily bad. But you can't raise rabbits with no work or with as little work as an equal number of chickens would take."

Another problem is the greater need for management. "A person can have a flock of chickens, throw them a bit of grain occasionally, shut them up in his kitchen at night and get away with it. Much more is required of the rabbit raiser. We found that it is best to start with a farmer who has had no experience with rabbits than with one who has 'raised' rabbits before under improper methods such as letting them run around the house. Also, farmers need regular visits to train, give new ideas, support, trouble-shoot etc. ...In areas where the traditional scavenger method of animal husbandry has been practiced, where animals are largely left to find their own livelihood, a fundamental change in attitude must take place for rabbits to be successful. To cage and regularly feed the animal is quite foreign, especially when the farmer and his family may be hungry. We must not underestimate this educational process."

To be economically feasible, the rabbit project must be based primarily on large amounts of green roughage. Though weight gain will not be as rapid, the gains will be inexpensive. The beauty of the rabbit in this situation is that it converts cheap roughage unfit for human consumption into meat of very high quality.

We then received an unexpected letter on the same subject from Gary Shepard in Nepal. "About 8 years ago I tried raising rabbits in the village, but nearly all the 80 young died and I gave up. Last fall I got a few tips and raising rabbits has caught on like wildfire now. The important points were: (1) Clean the pen daily, i.e., throw out all old grass, etc. (2) keep feed off the bottom of the pen by either building a feed rack or tying it up. (3) Make sure villagers build pens with bottom slats of bamboo or wooden rods so that it is as self cleaning as possible. (4) Avoid giving grass that is wet during the hot season. Though you might get away with it for a month or more, one day you will find that a bunch have died overnight. Cut grass in the morning and spread it out to dry excess moisture in a sheltered place (on top of the pen) and feed it in the evening. In the evening you can cut grass and dry it overnight. Rabbits do OK on a 90% banana leaf diet, but prefer a mix of foliage, weeds, etc. (5) Some books say not to give salt. This may be OK for cold climates, but if you don't, you risk the mother killing and eating her young, as is common here in the monsoon season. (I have never known it to happen to those who feed a little salt.) I put it in with a little ground grain made damp with water. Our villagers feed their rabbits a lot of mustard cake. They are far more profitable than chickens and require comparatively little grain."

We really appreciate receiving such letters. Let us hear from you about things experience has taught you.

KINNEY MITCHELL REPORTS ON HIS EXPERIENCE WITH RABBITS IN ST. KITTS. For some years we have followed Kinney's work with rabbits, which turned out to be quite a successful project. He kindly wrote up some highlights from his experience.

"We tried three basic diets. Rabbits that were fed 50% pellets and 50% green matter did best. Those fed only locally produced commercial pellets did second best. Those fed only greens suffered some losses due to feeding improper materials, but as a whole survived and grew, but not as fast.

"Many locally grown things that are considered rabbit feed turn out to be very harmful to rabbits. A healthy adult rabbit begins to suffer when these traditional bushes are introduced.

"We fed velvet bean, leucaena and banana leaves. Others added sugar cane tops, grasses and sweet potato and black-eyed pea (cowpea) vines. Most of our rabbits preferred velvet beans over other leaves (sweet potato, black eye pea, or green bean vines) or pellets, though a few preferred banana leaves. Bunnies began to eat the velvet bean leaves as soon as they could hop out of the nest box. We never had trouble from rabbits eating velvet bean leaves. They also ate the vine part. By the way, when cutting the velvet beans a brown stain got on my hands and clothes. This usually washed right off. [MLP: I stained my shirt with velvet bean vine and did not wash it off immediately. My wife, who excels in removing stains, could not save the shirt. Sweet potato vines will do the same thing.]

"We planted the velvet beans around the outside of the rabbit barn. They grew up the sides and actually covered the top of the barn. The shade helped keep the rabbits cool. The vines lived 3 years and grew vigorously, in both the hot and dry season. While we were heavily harvesting the leaves they would not make beans, but made tons of leaves. [Ed: Supposedly velvet bean vines die after the seeds mature. The lack of seed production is probably why these lived so long]. I guess the manure from the rabbits made them grow so well. Mice began to live in the leaves, but our cat kept them under control. We harvested the vines that hung over the front of the barn, and from the back and sides as they became too thick.

"Our barn is made from split bamboo for a roof. Once the velvet beans covered the roof, it was quite water tight and cool. We placed bamboo around the bottom to a height of 2.5-3 feet to keep out dogs and wire fencing on up to the top to keep out other things. The bamboo lasted 3 years.

"Our rabbits really liked the leucaena. They would eat the leaves and tender green stems and would also chew on the wooden stems. They seemed to enjoy pulling the soft bark off to eat and then chew on the wooden parts. We fed a lot of leucaena and never saw any problems, such as hair loss which is a reported problem with non- ruminants. Our leucaena are all improved types. Rabbits would also eat the dwarf wild leucaena that grows here if they were hungry, but it seems bitter and they did not like it very much. The improved leucaenas were preferred over pellets. Bunnies would also eat it as soon as they left the nest.

"Rabbits also liked banana leaves, which my tropical agriculture book says are very nutritious. The mature rabbits also liked the center part of the leaf, which has a celery-like texture. I cut the leaf away from the center part, then split the center 3/4 of its length. I could then hang these from the top of the cage so I did not need to worry about them getting soiled. Rabbits had to be very full not to eat all of them quickly.

"Rabbits also like the moringa and winged bean leaves, though we did not have enough of either to be very important.

"SOME PROBLEMS WE ENCOUNTERED [AND HOW WE ADDRESSED THEM]. 'I don't want to eat rabbit.' We invited 40 young adults from our

Sunday school class for a party at our house and served rabbit- fried, baked, BBQed, stewed with tomato and rice, rabbit with rice, and rabbit salad. Everyone ate heartily-over 30 rabbits. After that we never had to worry about people being willing to eat rabbit. It is now a special meat for holidays and special occasions. I recently had to make 40 pounds of rabbit salad for a wedding reception.

" 'Rabbits do not need water.' The common belief here is that animals (cows, sheep, goats, rabbits) get all the water they need from the grass and leaves that they eat. Some time after the class for new rabbit raisers, one said to me, 'Brother Kinney, you cannot believe how much better my rabbits do when I give them water.' I told him his milk cow would give more milk too if he watered it-and sure enough it did.

" 'Rabbits can survive on local brush.' As mentioned earlier, those that ate a lot of local bushes soon got sick and died. Rabbits that did not soon prospered and got fat. The smart raisers noticed the difference and changed their ways. The others would not listen to advice and soon had no rabbits.

" 'Rabbits will not grow in St. Kitts. They get diarrhea and die.' This belief has come about because of poor diet and a poor local strain of rabbit. The main rabbit raiser had a sickly, inbred strain. After he replaced his herd with our rabbits and changed his feeding, the diseases went away. We have a rule that if a rabbit gets sick, kill it. We do not try to doctor them. We do not want to keep sick rabbits around nor pass on any genetic susceptibility to disease. We have raised over 500 rabbits and butchered 300-400 more. During this time we lost 1 to mastitis (infected mammary gland), 1 to an unknown disease, 1 broke its neck during a thunder storm (and several mysteriously opened their cage door, jumped out and re-latched the door). We started with 6 unrelated females and 2 unrelated males. The next year we added the same number of unrelated rabbits. We tattooed all the breeding animals and kept careful records so as not to interbreed."

RAISING RABBITS IN PITS. Jeanette Swackhammer in Cameroon writes that she has "heard of a method of raising rabbits in the Sahel where rabbits were kept in pits. The rabbits would then dig their own burrows in the sides of the pits and would come out into the middle to feed. Some sort of enclosure was made to cover the entrance to their dens in order that they could be caught." This keeps them much cooler. It obviously would not work in sandy soil, nor during a rainy season unless drainage could be provided. I would expect rabbits to select a site in the open pit where manure would be concentrated, in which case it could be removed. However, disease could spread rapidly if it entered the flock. If you have had experience with this, let us know.

NEST BOX BEHAVIOR OF RABBITS. At ECHO's weekly seminar our interns share highlights of what they have studied during the week. I found the article that J. R. Crouse summarized on nest box behavior of rabbits so interesting that I asked him to write it up for you. Some of the things we worried about when we got our first rabbits, I now know, were normal rabbit behavior. He based the following on an article by Dr. James I. McNitt and George L. Moody, Jr. in the Journal of Applied Rabbit Research (Vol. 10, no. 4, 01987; publication discontinued in 1992).

It may well seem that a doe does not take much interest in her offspring. Closer examination, however, reveals that the reproductive behavior of the domestic rabbit is apparently based upon that of its relative, the wild rabbit. "Non-interest" behavior towards kits may actually enhance their chances of survival in the wild. Unlike many other domestic animals, does only nurse their young once per day, and for only a short period. In the wild this behavior has survival value because the infrequent, brief visits to the nest area by the doe decrease the chance of detection by predators. Domestic does also will not retrieve their young if they climb out of the nest box. Wild rabbit nests are built at the lower end of the burrow, causing all strays to be returned to the nest by gravity. Thus, the wild doe has had no selected behavior for kit retrieval.

As mentioned above, the doe is in the nest box for nursing for only a short time. The blind kits benefit if they are ready to receive the mother for suckling. Observation by Dr. McNitt showed that at about 22 hours since the previous nursing, the kits actively gathered in a group on top of the nesting material. It is critical that each kit nurse, as a missed suckling period decreases its chance of survival. Rabbit raisers who cover up the young when exposed may be interfering with their preparation for nursing. A few seconds after the doe has entered the nest box, the young contact the nipple. This quick detection is facilitated by pheromones (chemicals the mother secretes which are detected by smell).

Does were further observed depositing a few fecal pellets in the nest box at each nursing. Kits showed excitement over this event and nibbled on the pellets. Dr. McNitt feels this normal behavior (different from definite nest fouling) may be a means of inoculating the kits with intestinal microorganisms.

Another interesting observation was urination by the kits during nursing. After nursing, the kits vigorously dug into, and fluffed up, the nesting material. These may be adapted behaviors to promote drying of the nest in order to maintain nest health. The nest is only wetted (and immediately dried) once per day, instead of continually being soiled.

When kits open their eyes at about 10 days, they are approximately three times as large as at birth and have greatly improved motor coordination. Because larger kits will displace smaller kits in the struggle for space in the nest box, the boxes should be removed as early as possible. This will allow ample nursing space and opportunity. Two weeks is the maximum time to keep young in a nest box.

MANUAL ON RAISING RABBITS FROM HEIFER PROJECT. Dr. Steven Lukefahr sent us a copy of his new book, The Rabbit Project Manual: A Trainer's Manual for Meat Rabbit Project Development. In addition to coordinating the International Small Livestock Research Center at Alabama A&M University, Dr. Lukefahr works closely with Heifer Project International assisting rabbit projects around the world.

Two things make this book different from most rabbit books in our reference library. First, it is written with Third World applications in mind. Second, it is a "trainer's manual," presented in the form of "Instructional Modules." Each module is designed to complement a development worker's own personal experience raising rabbits as he prepares lessons to share with others.

The book is divided into two sections: Instructional Modules and Stages of Rabbit Project Development. The 11 modules cover all the bases (breeds and selection, housing, feeds and feeding, reproduction, disease control, marketing etc.). Modules are well illustrated by diagrams, charts, and photographs and each one is followed by suggested lesson plans, training activities and helpful references. The second section, Stages of Rabbit Project Development, deals with the logistics of rabbit project development, covering: project feasibility, project design, project monitoring and project evaluation.

Copies of this spiral bound, 8 1/5" x 11", 103 page book are available by writing the publisher: Heifer Project International, P.O. Box 808, Little Rock, AR 72203, USA. A donation of US$10 is suggested.

HOW GREAT IS THE DANGER THAT RABBITS MIGHT ESCAPE FROM YOUR PROJECT AND "CREATE ANOTHER AUSTRALIA"? I asked this question of Fremont Regier in Botswana after he had been so kind in answering other questions. His reply follows: "I've heard this argument before but I believe it is a rather ridiculous one. The problem in Australia was caused by the introduction of wild rabbits, not of domestic rabbits. J. E. Owen in "Rabbit Production in Tropical Developing Countries: A Review," Tropical Science, 1976, 18 (4) pages 203-210 says, 'One aspect of rabbit keeping which causes concern to many developing countries is the potential threat of escaped domestic stock and their effects upon other agricultural enterprises. The unfortunate experience in Australia is probably responsible for this. It should be pointed out, however, that in Australia in the mid-19th century domestic rabbits were kept in almost every town and city. Those which were liberated or known to have escaped gave little or no trouble, except around Sydney where they became established and merely constituted a local nuisance. However, this problem paled into insignificance compared with the damage caused by wild rabbits which were introduced later on. All successful mainland invasions (of England, Australia, New Zealand and South America) have developed from the introduction of wild stock. But even in Australia wild rabbits have not spread into the tropical parts of the country.

" 'There are many instances of escaped domestic rabbits multiplying on small islands, to the detriment of the vegetation in both tropical and non-tropical climates. The burrowing habit has undoubtedly helped them to withstand periods of very high temperature and water shortage in warm countries. On large land masses such as Africa, escaped domestic stock are extremely unlikely to cause serious problems. On small islands with no natural predators, however, the situation may be very different, although the island of Malta has both wild and domestic rabbit populations and has suffered no such problems. In these situations expert advice from ecologists who are familiar with local circumstances should be sought.'"

The cited article by Owen is included in ECHO's Technical Note "Observations on Raising Rabbits in the Tropics." Also included is a review of some of the literature available from World Neighbors. The most unusual is a manuscript called "Commercial Rabbitry Handbook." This is written by two Ghanaians who have an interesting method of reducing labor and number of cages by housing rabbits in large groups which they call intensive gangs. Even does about ready to kindle are caged in pairs. Also interesting is a method called "rotary crossing" that they use to ensure that a uniform number of bunnies are produced each week even in a large rabbitry. Request this Note from ECHO if you are interested.

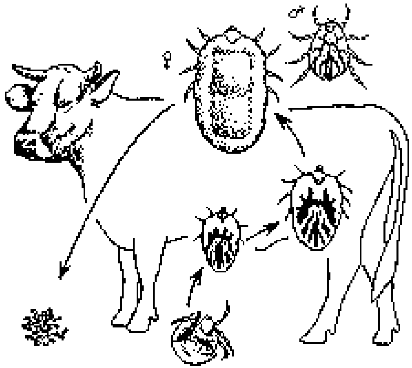
Health and parasites

TWO SERIES ON VETERINARY CARE. Raising Healthy [Animals] Under Primitive Conditions. These booklets provide a lot of information! Each booklet (80-180 pages) summarizes basic care of an animal, with housing and equipment, flock/herd management and nutrition, and disease and parasite prevention and control. The books are like summaries of a textbook on each animal. Nutrient components of various tropical feeds is particularly interesting. Medicines and dosages for common illnesses are also listed, for those with access to commercial treatments.

The booklets are written by veterinarians with Christian Veterinary Mission. Titles in the series include Pigs, Rabbits, Fish, Goats, Beef Cattle, Poultry (also in Spanish: Aves de Corral), and Dairy Cattle. Booklets are US$5 each in developing countries, $7.50 elsewhere. Books on Horses, Sheep, and Drugs and Their Usage are expected in 1996. Look for: Slaughter and Preservation of Meat, Where There Is No Vet (in the style of WTINDoctor), and some translations of these books into Spanish and French in 1997. Write Dr. Leroy Dorminy, the founder of Christian Veterinary Mission, 19303 Fremont Ave N, Seattle, WA 98133, USA; phone 206/546- 7343; e-mail ald@CRISTA.wa.com.

Ethnoveterinary Medicine in Asia: an information kit on traditional health care practices is another excellent publication by IIRR. This 4-part kit (400 pp.) outlines remedies using locally available plants and simple techniques. Traditional practices throughout Asia were collected and discussed among workshop delegates from seven Asian countries.

The booklets are in IIRR's very hands-on, well-illustrated style. The first book includes the preparation of medicinal plants, simple surgeries, and a list of all the ethnoveterinary plants (about 250) listed in the series. Many of the plants are weeds or food plants common in the tropics; some are specific to Asia. The other three books are on ruminants, swine, and poultry. Diseases are discussed according to symptoms, causes, prevention, and treatment. Practical dosages and complete instructions for preparing and administering the herbal medicines are given in every case.

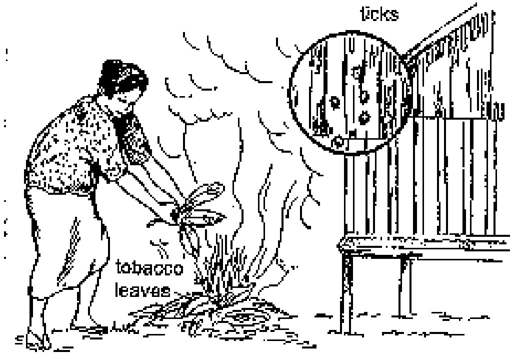


eliminating ticks with tobacco leaves

A few examples from each book should give you an idea of the material. For ruminants: treat constipation with a salted banana blossom; 10 plants used for internal parasites; safe management of infectious diseases; and simple housing models. For swine: treat piglet anemia with Moringa leaf extract; use Leucaena seeds to treat for roundworm; and various rinses for eye infections. For poultry: smoking bird houses for ticks, lice, and mites (see picture from the book); and how to care for infected wounds using oil and ash. To order: in the US, send a check for US$17.25 payable to IIRR; overseas, pay only by int'l money order, US$18 for overseas surface mail at IIRR, 475 Riverside Dr., Room 1035, New York, NY 10115, USA; phone 212/870-2992/fax -2981; e-mail iirr@cce.cornell.edu. In Asia, contact IIRR Bookstore, Silang, Cavite 4118, PHILIPPINES; phone (63-9-69)-9451/fax -9937; e-mail iirr@phil.gn.apc.org. Pay US$11.40 in the Philippines, $18 airmail within Asia.

NATURAL VETERINARY MEDICINE by Uly Matzigkeit. The Swiss agricultural information network, AGRECOL, has published a 183-page book on ectoparasites of animals in the tropics (i.e. in contrast to internal parasites). They see this as a sequel to their exceptionally useful book Natural Crop Protection in the Tropics by Gaby Stoll. Consequently, 80 pages are devoted to "Insecticidal, repellent and wound healing plants." The botany and propagation of the plant is summarized (often a botanical drawing is pictured to help in identification), then uses are briefly discussed and references listed. Sometimes I find this crucial how-to section frustratingly brief with many unanswered questions, but this is probably due to the inadequacies in the literature upon which they had to rely. A research scientist could find a wealth of research ideas by looking for these gaps.

The first 86 pages discuss the ectoparasites of primary importance. Each section includes a picture of the parasite (see picture from the book), a discussion of its life cycle, hosts, symptoms/damage and control measures. Some "gems" from the general discussion follow.



ectoparasites

"Plant preparations applied for ticks should be applied especially when resistance to ticks is low. Some factors having influence on tick resistance are: (1) Livestock shows its lowest resistance in tropical autumn. (2) Female calves are more resistant to ticks than males. (3) Young cows are more resistant than old ones and sucking calves more than their mothers. (4) Pregnancy might lower resistance, especially in the last stage. (5) Lactation also lowers resistance, especially at the end of lactation.

"It is of great importance to assure a confrontation of cattle with ticks and tick vector diseases in areas where anaplasmosis and babesiosis is prevalent (not more than 10 engorged female ticks/animal!). Animals kept tick-free for long periods will lose their immunity to these diseases and a heavy reinfection might be fatal. Newborn animals should not be kept tick free for the first half year, when they can gain a natural immunity."

The book can be ordered in English or French for about US$25 plus postage from Margraf Verlag, P.O. Box 105, 97985 Weikersheim, GERMANY; fax 49-(0)7934-8156. The book is also available for 28.50 SFr (about US$23) plus postage from AGRECOL, c/o Oekozentrum, CH-4438, Langenbruck, SWITZERLAND. By the way, we asked if an endoparasite book is planned, but it is not.

POULTRY IN TICK CONTROL ON CATTLE. Nicola Mears wrote, "Here in coastal Ecuador the area has been transformed in the last 20 years from tropical forest to cattle farms, so the ecology has changed dramatically. Perhaps this is why we have a population of ticks that is absolutely out of proportion. Controlling them has become worse over the past 5 years. All animals must be sprayed with insecticide at least weekly. Until a correct dose was established many cattle and horses were lost (and who knows how many children were affected). I am continually asked if there is a biological control for ticks."

The International Centre of Insect Physiology and Ecology in Nairobi says that poultry might be able to play an important role in reducing tick populations. A brief excerpt from Spore magazine quotes their studies as showing that engorged ticks generally drop from their hosts either late in the evening or early in the morning. This leads them to suggest that, if cattle are kept in their kraals [enclosures] at those times, and chickens are allowed access to the kraals, the chickens would pick up the engorged ticks.

Marsha Hanzi with the Instituto de Permacultura da Bahia in Brazil wrote, "Regarding ticks on cattle, this is also a serious problem in the Brazilian altiplano, where it has been successfully kept within limits with the guinea fowl. They have the advantage over the chicken of liking the hot climate and of adapting to the wild. They virtually become wildlife, living and reproducing without human aid.

"Proliferation of ticks is a sign of soil degradation, at least here in Brazil.

On our farm we had an outbreak only when the pasture became old, even though the neighbors farms were always infested. Healthy animals on healthy soil have relatively few ticks. I personally suspect it has to do with microelements which are often deficient in tropical soils. One homeopathic doctor suggested that adding a little sulfur to the cattle's drinking water helps increase resistance. It seemed to work in our case."

These comments were from L. E. Andrews in Houston, Texas: "I think the solution is with guinea fowl rather than chickens. They love to eat ticks, as well as beetles, spiders, flies, etc. A big plus is that they eat snakes. We have a lot of copperheads in this area. A friend bought some land that was infested with copperheads and some rattlesnakes. In 3-4 years after bringing in some guinea fowl you could not find a snake on the property. They eat the small snakes and gang up on larger ones, pecking them to death. They also eat young mice. They are the best watch dog you can have to alert you of any activity at night.

"I'd recommend raising the young (called keets) in a pen near the feed lot to help them bond to the cattle. Feed them just a little grain and a lot of ticks (you could hire kids to collect the ticks). When they are mature, they will form teams moving through the fields and feed lot. Feed them only a little bit, at night, in the feedlot with the cattle to encourage them to center around that area."

[Ed.: Thanks for the good suggestions. Beware, though, if you have a lot of mulched gardens. Several years ago ECHO obtained 12 guinea fowl because I read that they would go through gardens eating only insects and leaving plants alone. A week after we turned them loose on the farm we butchered them all. They did not eat the plants, but they were a disaster in our heavily mulched gardens. Their constant scratching quickly dug out some plants and buried others. If we did not use so much mulch they would have become a permanent fixture here.]

David Showalter in Paraguay said, "Concerning ticks, one farmer keeps chickens in a grove of trees, where they run loose. When the cattle come into the woods in the heat of the day, the chickens eat the ticks right off of the cattle. The cattle get used to this and do not seem to mind."

From Daniel Priest in Bolivia: "I just received the latest EDN and noticed that people continue mentioning chickens for tick control in cattle. Since I have had a little experience with this, I thought I would write.

"First, good 'indicus' (hump on the back) cattle are naturally very resistant. Crossing with European breeds usually gives potential for higher production, but also greatly increases the tick problem. There is a wide variation in degree of tick resistance in those cross-bred cattle, so selection can be very effective.

"Several years ago I bought Brown Swiss bulls to cross with Nelore. The bulls, and their progeny, had a very high capacity for picking up ticks. The cattle would come to loaf in the yard where we also raised chickens. The chickens would pick the cattle clean, even jumping a couple of feet in the air to grab a juicer, and the cattle seemed to enjoy it. A side advantage was the nutrition of the chickens.

"After about three years I started to notice indications of a significant transfer of fertility from the pasture to the loafing area. Because of this I stopped letting the cattle spend much time in the same area. Now, although the cattle do spend a little time near the chickens, both cattle and chickens seem to have lost the custom. Apparently the two must spend a good bit of time together to get acquainted and start to help each other out.

"A practice that is becoming more widely used in Brazil is the feeding of the aerial part of the cassava plant to cattle. It must be chopped and left for a day before feeding to lower the toxicity. Not only does it contain around 12% crude protein, but it controls ticks, probably due to the small amount of prussic acid remaining even after drying for a day. Although this practice is encouraged by Brazilian researchers, I still wonder if it might not adversely affect the beneficial micro-organisms in the rumen as well as the ticks." [Does anyone have more information concerning this? Perhaps an extension bulletin from Brazil?]

TICK CONTROL POTENTIAL. According to a USDA press release, young ticks died and adult ticks shied away when they touched extracts from an African plant, Commiphora erythraea (Haddi tree). A syrupy oil bearing the chemicals was made from the thick gum of the plant. "In Africa, the oil is rubbed on cattle to repel ticks and insects and soothe cuts, bruises and scabies. It is also used as a perfume because of its pleasant odor. The plant is closely related to myrrh, known for its Biblical reference as a gift of one of the wise men." We have been unsuccessful in obtaining seed for this plant, or even to learn any of its common names. Can anyone in Africa help with information or seeds?

HOMEMADE DEWORMER FOR GOATS. According to the September 1991

Sustainable Agriculture Newsletter, some small farmers in the Philippines are using ipil ipil (Leucaena leucocephala) seeds to deworm young goats. About 50-100 young seeds are removed from the pods and are pounded to form a paste. This is mixed with 5-8 ounces of water and given to the goats as an oral drench. The laxative effect kills or expels the ascaris (Ascaris lumbricoides?) and other stomach worms.

VETERINARY STUDENTS AT MICHIGAN STATE UNIVERSITY ARE AVAILABLE TO ANSWER QUESTIONS. Since 1986, students in the veterinary department at MSU who have an interest in Third World development have been organized to help missionaries and others doing similar work when animal health problems perplex them. They get an average of 10-20 requests per year. There are two main ways in which they have helped people to date. (1) People have written with disease symptoms and they have tried to diagnose the likely problem. A few times someone from MSU or known to them has been traveling in the area and was able to actually visit to assist with especially difficult problems. (2) They have sent literature that they believe will answer a problem, or particular articles that someone has requested.

Contact the faculty director Dr. Edward C. Mather, Coordinator of

International Programs, G-100 Veterinary Medical Center, College of Veterinary Medicine, Michigan State University, East Lansing, MI 48824-1314, USA; phone 517/432-2388; fax 517/432- 1037.

COURSE IN TROPICAL ANIMAL HEALTH AND PRODUCTION (IN FRENCH). After receiving his masters in horticulture from Florida, Pete Ekstrand went to the Prince Leopold Institute of Tropical Medicine in Antwerp, Belgium for a year of study before beginning work in Zaire. I could tell from his exciting letters that he was gaining much from the studies, so I asked him to write a bit about the school. "The course lasts for ten months (early October through June). It consists of two programs, one in animal health and hygiene and the other in animal production. In the first program we studied tick-borne diseases, trypanosomiasis, other protozoan diseases, insect control, infectious disease and the role of veterinarians in prophylactic campaigns. In the second we studied agronomy, fodder crops and natural pastures, animal husbandry, management of farms and stations, construction, molasses and non-protein nitrogen, agricultural by-products, trade policies, wildlife use, hydrobiology, fish farming, handling of hides and skins, biometry and statistics.

"So what do I think of it? I have thoroughly enjoyed the course! Although French is a second language and I was able to study it only four months, I have had no problem following and understanding the material, except for the expected new vocabulary. In fact, they greatly helped my French. The students this year are from Bolivia, Spain, Zaire, Benin, Ghana, Cameroon, Ivory Coast, Togo, Belgium and the USA (myself). It has been enjoyable and enlightening to talk with them about situations and potentials in their countries. The professors have had experience in developing countries and are current in what they teach. I have been impressed with their knowledge and understanding of all the parameters involved in development. I am sure the year will greatly benefit my future work in Zaire."

The only fee mentioned in the catalog is 42,000 BF registration, about US$1400. For more information, write to Institut de Mdecine Tropicale Prince Lopold; Dpartement de Production et Sant Animales Tropicales; Nationalestraat 155, B-2000 Antwerpen, BELGIQUE; phone 32/3/2476666; fax 32/3/2161431. BASIC SEED HARVEST GUIDELINES FROM ECHO'S SEEDBANK. VOLUNTEERS IN COOPERATIVE ASSISTANCE (VOCA) is a nonprofit organization which recruits volunteer consultants (farmers, executives, and specialists who are US citizens with at least 10 years' field experience) for short-term assignments in developing countries and emerging democracies.