EDN ECHO Development Notes

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Edited by Dawn Berkelaar and Tim Motis

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

Issue Highlights

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Congratulations to Dr. Martin Price on his Retirement!

The end of August marked the beginning of Dr. Martin Price's retirement. During his 27 years of involvement at ECHO, the organization grew in ways he could not have imagined when ECHO began its global ministry in 1981. He commented, "When I finished Issue 1 of *EDN*, I wondered where I would ever find enough helpful material to write the second issue. I was especially pleased to help write the special 100th issue just before I retired." Dr. Price and his wife Bonnie now look forward to new opportunities for travel and service. Dr. Price is already active as a volunteer at ECHO, primarily writing, speaking, meeting with visitors studying at ECHO and consulting on ECHO's behalf.

We take this opportunity to introduce Dr. Tim Motis, who joins Dawn Berkelaar as co-editor of EDN. Dr. Motis is the new Director of ECHO's Agricultural Resources Department and also continues as Seed Bank Director. Dr. Motis grew up in Liberia and worked in Ethiopia for two years before earning his PhD in horticulture at the University of Florida. He then directed a Small Farm Resource Development Project that ECHO operated in Haiti for three years. Since 2006, he has served with ECHO at our Florida headquarters.

Applying Calcium Carbide to Induce Flowering in Pineapple

By Brian Hilton
World Vision, Mozambique

Pineapple, *Ananas comosus* L., is both a lucrative and flexible crop. It requires good drainage and grows well on coarse textured soils. We get the best results in dark loamy sands that have some organic matter present, but it will grow even in coarse sand with almost no fertility, where few other crops grow. While the pineapples are smaller, they are still acceptable to farmers here. Pineapple is also drought-resistant.

Due to an oversupply of fruit at harvest time in Mozambique, prices received by pineapple farmers drop from US$0.90/pineapple to US$0.25/ pineapple for large 2 kg pineapples (smooth cayenne type). Happy are the farmers whose pineapples mature before or after the peak season because they get more than three times the peak price. Production gluts are common during peak season in areas where many farmers are producing and selling the same perishable crops.

The solution to production gluts is to extend the season (i.e. have a harvestable product a bit earlier or later than most farmers) or to grow totally out of the normal season. Most crops are not easy to grow out of season. However, pineapple flowering is easily induced at any time of the year though the application of cheap chemicals. The most common compound used to stimulate flowering for commercial pineapple growers is ethephon, a commercial product that when mixed with water produces ethylene gas, a flower inducing plant hormone. It is somewhat toxic and needs to be applied with protective eyewear. A much older method of inducing flowering uses calcium carbide, which can be safely applied by farmers without any special equipment. We have observed that trying to apply the latest commercial technologies to small farms does not always work, as the varieties, inputs and methods are not all appropriate to the situation of small-holder farmers. The introduction of this older technology fits in well with

Mozambican farmers' lack of equipment and resources.

Calcium carbide in contact with water (or humidity) produces acetylene gas, which induces flowering. (The acetylene molecule is the same shape and almost the same size as the ethylene molecule, and so is able to mimic that natural plant hormone.)

$CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

The calcium hydroxide formed in the reaction causes minimal leaf burn but no serious harm. It eventually turns into a harmless calcium carbonate precipitate (limestone is primarily made of calcium carbonate) through the following reaction:

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

Calcium carbide reacts immediately when it comes into contact with water, producing a flammable gas. Before the days of electricity, miners around the world wore lanterns (carbide lights) on their heads. The light came from burning the gas that was produced as water was very slowly dripped onto the calcium carbide. Uncontrolled addition of water to calcium carbide could produce so much acetylene gas that it could be explosive if ignited. Calcium carbide should be kept dry in airtight containers. I handle very small amounts of it without gloves, but it eventually absorbs moisture from my hands, reacts, and burns my flesh. It is probably the alkaline calcium hydroxide that causes the burning.

So calcium carbide should be applied to pineapple either with gloves or a spoon. Most of our farmers use spoons to apply dried granules.

Induction of flowering in pineapple can be done any month of the year. We have had good success inducing flowering when the plants were 8-12 months old. It is best to pick large pineapple plants to induce, since small plants will produce smaller pineapples. Farmers can induce flowering up to one month before the normal flowering period to take advantage of high off-season prices. Place 0.8-1.0 gram of calcium carbide in the whorl of the plant (the opening at the very top) at sunrise (Figure 1). On nights with dew, the whorl will contain a little water, which makes the calcium carbide even more effective. Cool cloudy days are the best days for calcium carbide application. The most difficult time to induce flowering is when it is hot and dry. Calcium carbide burns the leaves slightly and stresses the plant. We have considered putting a little water in the whorl to reduce the stress during hot, dry periods of flower induction. We recommend reapplication if heavy rain occurs within a few hours of the initial application.

A US $6.00 bottle (500 g) of calcium carbide can induce the flowering of 500 pineapples. Pineapples grown out of season sell for at least twice as much as peak season fruits. We calculate that difference at a conservative $0.30/pineapple. So an investment of just $0.012 per pineapple returns $0.30 six months later. There are not many agricultural investments more profitable than stimulating flowering out of season.

Unexpected Problems in Introducing the Technology

Because of the high returns and the simplicity of the technology, we thought its introduction and adoption would be rapid. That assumption was very wrong. Theft of the out-of-season pineapple during the night was a problem in some areas, greatly discouraging farmers. Organized groups of thieves with machetes would come at night and steal as many of the ripe out of season pineapples as they could carry and then sell them in distant markets. Also, farmers making the most profit from calcium carbide would sabotage the field days by vocally complaining in order to discourage others from using the technology. An informed agricultural extension agent explained that farmers using the technology were afraid that the prices would drop if their neighbors began to produce out-of-season pineapple too. To alleviate this concern we tried to convince farmers of the large demand for pineapple (in the fresh market) and to help them sell in innovative ways by advertising and making roadside stands.

The most serious problem we encountered was a low percentage of pineapple flowering after calcium carbide application. Since the stomata of pineapple plants are open only at night, we suspected that the poor flowering was due to the fact that farmers were applying the calcium carbide in the mid-morning. We did a number of experiments to determine the best times of application (see Table 1).

Farmers were involved in the experiments, and during the field day, groups went around and counted the percentage of pineapple that had flowered. Once again hands-on experience convinced not only farmers but the extension staff and myself that earlier application times were necessary. The leaves of the smooth cayenne pineapple are spiny at the end so farmers get scratched. We suspect that some of the chemical falls outside of the funnel as farmers are leaning and reaching with a spoon in order to decrease leg scratching. Because of these realities, we consider flower induction greater than 70% to be satisfactory. Plants that do not flower can be induced again or left to flower during the normal period. Most farmers prefer to stagger production so that weekly sales of fresh pineapple are possible. The closer the pineapple is to normal flowering the easier it is to induce. We have achieved over 90% flowering

Table 1: Percentage of pineapple flowers successfully induced by calcium carbide applied at 3 different times of day to pineapple at different ages. *Sunrise on the date of application was 4:29 am.

Time of Application									
	5:00 am*			8:00 am			6:00 pm		
Age of pineapple plant (months)	8	10	12	8	10	12	8	10	12
% plants successfully induced	70%	68%	81%	28%	3%	8%	47%	21%	32%

by applying the calcium carbide to 12-month-old pineapple plants one month before normal flowering.

Seasonal timing of the calcium carbide application is also important. Pineapple develops most of its sugars in the last month of maturation. Hot temperatures in the last month of maturation result in sweet fruit, while cool temperatures result in fruit that is less sweet. Here in central coastal Mozambique, we are at latitude 18ºS, the same distance from the equator as Cuba and with a similar climate. However, we are in the southern hemisphere. June and July are our coolest months, so we encourage farmers to stagger their production so that less pineapple is produced during these cooler months.

Figure 1: A farmer applies calcium carbide in a pineapple field intercropped with maize. A small amount of water was in the funnel which reacted immediately to produce the "smoke" visible in the photo. Visual confirmation is important for new farmers trying the technology. Photo by Brian Hilton.

Calcium carbide is a very useful chemical. A small amount of calcium carbide spray on tomatoes can force uniform ripening. Small amounts of calcium carbide can also be used (placed dry in a paper bag) to ripen fruit such as banana. These interventions produce higher prices for market-oriented farmers. However calcium carbide has been much criticized because it contains trace amounts of arsenic and produces trace amounts of phosphine gas. I suspect the concerns about calcium carbide are overblown but we are experimenting with alternative natural methods of ripening bananas.

Import Issues

Besides demonstrating the calcium carbide to farmers, we had to help the local seed store stock the chemical. We also helped the importer in the capital of Maputo to import calcium carbide from South Africa. Working to ensure the input supply is the kind of thing I never like doing as a missionary. I view it as side-tracking me from working with farmers. However it is necessary to ensure inputs are available in order to move to a more intensive agricultural system. We made numerous telephone calls to the factory in South Africa and arranged the quote for the importer in Mozambique. We made sure that we were paying enough so that the importers and store owners were also making money. Store owners who do not make money selling calcium carbide will not stock it. Calcium carbide was promoted as widely as possible amongst farmers to create a threshold demand that would guarantee the future sustainability of calcium carbide sales.

Figure 2: Pineapple seven weeks after calcium carbide application. Residue appears on the flower and leaves. Slight leaf burning is evident on leaves which seven weeks previously were part of the whorl. Photo by Brian Hilton.

Conclusion

I wish I could say that this technology is already sustainable. It is not yet. We were too confident that flower induction would work, while having very little experience using calcium carbide. We lost about two years promoting calcium carbide widely without fully appreciating or understanding the problems that were occurring in the field. We were slow in interacting with farmers. But when we finally did begin to interact with farmers, we got much better results. Conducting participatory trials with farmers answered many questions and put us back on the right track. A core group of farmers is now using calcium carbide successfully to induce pineapple flowering.

Inoculation of Leguminous Crops and Trees

By Lindsay Watkins
ECHO Seed Bank Manager

Soil nitrogen is one of the most limiting factors in agriculture. Nitrogen is essential for plant growth, being a key component of protein, chlorophyll, enzymes, and genetic material. Though nitrogen is abundant in nature—cycling between the atmosphere, soil and living organisms—it is only directly available to plants when converted through biological or industrial processes to certain forms, primarily ammonium (NH_4^+) and nitrate (NO_3^-). Some nitrogen is made available to plants through the decay of existing soil organic matter (e.g. manures and plant residues) or residues of the current crop. A small amount of atmospheric nitrogen is also "fixed" and converted to NO_3^- through lightning. Generally, however, these inputs are not sufficient to replenish the nitrogen taken up by the crop and removed with the harvest. Adequate

replacement of plant-available nitrogen in the soil, then, is accomplished by applying fertilizers (inorganic, manure, etc.) and through biological nitrogen fixation.

Nitrogen fixation in the soil is primarily accomplished through a symbiotic relationship between plants in the legume family and specialized bacteria (rhizobia, bradyrhizobia, or azorhizobia). Most legumes can be identified by their double-seamed seed pods. Examples include cowpea, peanut, clover, crotalaria, leucaena trees, and velvet bean. When the appropriate bacteria are present in the soil, the bacteria infect the roots of the leguminous plant, causing the plant to develop a nodule. This nodule houses the bacteria and supplies sugars for their growth. In exchange, the bacteria trap atmospheric nitrogen (N_2) and convert it into ammonia (NH_3), which is ultimately converted into NH_4^+ and amino acids that are utilized by the plant. Different rhizobial bacteria nodulate different legume species, so it is important to match the two.

Figure 3: Nodules on plant (Aeschynomene sp.) roots, indicating colonization by rhizobial bacteria. Photo by Tim Motis.

When a legume is growing in its native habitat, it is likely that the appropriate bacteria are present in the soil. If nodules are present on the roots, especially along the taproot near the crown, and if the nodules are pink or red inside, then an appropriate bacterial strain is living in the soil and actively fixing nitrogen in symbiosis with that legume (Figure 3). If not, it is necessary to inoculate with the matching bacteria. Note that sometimes a crop growing where it has not been grown in recent years may still form nodules and even fix some nitrogen. Some rhizobial bacteria are generalists and can fix nitrogen in relationship with a range of legumes. But it is possible that more nitrogen is fixed if specific legumes are matched to the bacteria that nodulate them best. One way to encourage this is to introduce to the soil rhizobia from the crop's native habitat.

The benefits of having the best kind of rhizobia in the soil are many. Reduced need for fertilizer application (specifically inorganic nitrogen) is the most obvious. This means reduced costs as well as improved nutrient efficiency. Nitrogen fixed by bacteria is not as quickly leached from the soil as is applied nitrogen, resulting in a more stable nitrogen pool. Soil quality is also enhanced by inoculation, which fosters microbe diversity and residual nitrogen build-up over time. Finally, forage quality is improved when legumes are inoculated, since the increase in nitrogen levels promotes an increase in the legume's protein content.

Just because a legume can fix nitrogen doesn't mean that some nitrogen fertilization might not be helpful. An initial application of inorganic fertilizer or manure can help stimulate plant growth just after germination until nodules are developed. Adding too much nitrogen to the soil, however, can cause the rhizobia to slow down or stop producing nitrogen. More important than adding nitrogen is remedying deficiencies of other essential nutrients. The process of fixing nitrogen is complex, requiring input from the plant as well as the bacteria. A healthy plant will fix more nitrogen than a stressed one, so it is important to prevent nutrient deficiencies, drought stress, and other stresses.

How to inoculate

In most cases, the best method of inoculating legumes is to apply the inoculant to the seed. Commercial preparations of live rhizobial bacteria come in various forms, the most common of which is in a peat or humus mix. The peat keeps the rhizobia moist and helps the bacteria stick to the seeds until they germinate. Inoculants also are sold in liquid and granular form.

With peat-based inoculants, it is helpful to add a "sticking agent." Mix one part sugar, honey, or syrup with nine parts water, and then sprinkle this mixture on the seed. Do not make the seed too wet, or the inoculant will wash off. The sugar in the sticking agent also provides a temporary food source for the bacteria until the seed has germinated and begins producing its own sugars. Once the seed is damp, add the inoculant. If the packaging did not provide application recommendations, adding about six teaspoons of inoculant to one kilogram of seed should provide sufficient inoculation.

Rhizobia thrive in cool, moist, aerobic conditions, so take care when planting inoculated seed. The seed bed should be thoroughly moistened before sowing; it is also helpful to sow during the cooler parts of the day (early morning or evening). Do not allow inoculant or inoculated seed to dry out or be exposed to the sun. In the tropics, it may also be necessary to increase the amount of inoculant used. According to the University of Florida Extension Service, most North American manufacturers do not take into consideration tropical conditions when recommending the amount of inoculant to apply. High temperatures and dry conditions (especially in the soil) might make it necessary to apply *twice* the recommended amount for large seeds and *five times* the recommended amount for small seeds. If inoculation does not appear to be successful, increasing the inoculation rate may solve the problem.

Sometimes it is better to apply the inoculant to the soil after seeding. If the soil is hot, dry or acidic, or if the seed is

pelleted or treated with a chemical, the rhizobia may survive better if applied directly to the soil. This can be done in a water solution or as a band of peat-based inoculant shallowly incorporated into the seed bed. Do not apply inorganic fertilizer, pesticide, or any other chemical directly after inoculation, as these may kill the rhizobia.

How to determine successful inoculation

Check for good root nodulation by digging up (rather than pulling up) the plants to avoid stripping off the nodules. Nodules should appear on the taproot and lateral roots near the crown of the legume within 21-28 days. Effective nodules are large and, when mature, show pink or red coloration inside. This color is produced by leghemoglobin, a compound similar to hemoglobin in human blood, which carries oxygen. Oxygen actually inhibits nitrogen fixation, so the leghemoglobin traps any oxygen that may interfere with the process.

Just because a plant is producing nodules does not mean those nodules are effective. Unproductive nodules are small and distributed throughout the entire root system. When cut open, they are white or grey to pale green. However, immature effective nodules can also have white or green coloration. The difference lies in the number of non-pink nodules: a plant that is properly inoculated will have a small percentage of white or green (immature) nodules; an improperly inoculated plant will have nearly all white or green (ineffective) nodules.

Trouble-shooting: why does inoculation fail?

There are several reasons why inoculation may be unsuccessful.

Wrong inoculant: as mentioned earlier, it is important to match the legume species to the appropriate bacteria that can effectively nodulate that plant. Legumes have been divided into groups based on what bacteria colonize them. These are called cross-inoculation groups. Most manufacturers produce rhizobia mixes for each cross-inoculation group, so it is not essential to know exactly which bacteria species you need. Nevertheless, Table 2 contains a list of the cross-inoculation groups and the rhizobia that colonize them.

Poor soil conditions: Rhizobial bacteria grow best at a temperature of 28-30°C (82-86°F). If soil temperatures are too high, especially during establishment, the bacteria will not survive. A pH of 6-7 is optimal for rhizobial growth, while acidic conditions inhibit growth. Most likely, however, if the soil is suitable for plant growth, it will also support rhizobia.

Dead inoculant: inoculant is a biological product, meaning it contains living organisms. Consequently it does not have a long shelf life. A quality inoculant should last six months if stored properly. This makes the expiration date printed on the packaging very important. If the expiration date is past, discard the inoculant and purchase fresh material. Even if the expiration is still current, poor storage and handling during shipment may have killed the bacteria. Buying from a local source, if possible, may be better, though storage conditions can also be unreliable in this case.

Table 2. This is a generalized list of cross-inoculation groups and the corresponding rhizobia, collected from several sources. The list changes as new relationships and bacteria are researched. When purchasing inoculant, the most important information to bring to the manufacturer is what legume species you wish to inoculate.

Group/ Rhizobia	Host species
Alfalfa *Rhizobium meliloti*	*Medicago sativa* (alfalfa) *M. lupulina* (black medic) *M. polymorpha* (bur clover) *M. orbicularis* (button clover) *Melilotus* spp. (sweet clovers; e.g. white and yellow)
Clover *Rhizobium trifolii*	*Trifolium* spp. (clovers) *T. alexandrinum* (berseem clover) *T. grandiflorum, T. campestre* (hop clover) *T. hirtum* (rose clover) *T. hybridum* (alsike clover) *T. incarnatum* (crimson clover) *T. nigrescens* (ball clover) *T. pratense* (red clover) *T. repens* (white clover) *T. resupinatum* *T. subterraneum* (subterranean clover)
Cowpea "Cowpea rhizobia" group or *Rhizobium* sp.	*Aeschynomene* spp. *Albizia* spp. *Arachis hypogaea* (peanut) *Alysicarpus ovalifolius* (alyce clover) *Cajanus cajan* (pigeon pea) *Crotalaria* spp. *Indigofera hirsuta* (hairy indigo) *Lespedeza* spp. *Leucaena* spp. *Mucuna pruriens* (velvet bean) *Phaseolus lunatus* (lima bean) *Pueraria montana* var. *lobata* (kudzu) *Stylosanthes humilis* *Vigna mungo* (mung bean) *Vigna subterranea* (Bambara groundnut) *Vigna unguiculata* (cowpea)
Lupine *Rhizobium lupin*	*Lupin* spp. (e.g. blue, white lupine) *Lotus* spp.
Pea and Vetch *Rhizobium leguminosarum*	*Lathyrus* spp. *Lens* spp. *Pisum sativum (peas)* *Vicia faba (broad bean)* *Vicia grandiflora (bigflower vetch)* *Vicia sativa (common vetch)* *Vicia villosa (hairy vetch)*
Bean *Rhizobium phaseoli*	*Phaseolus vulgaris* (common bean)
Soybean *Bradyrhizobium japonicum*	*Glycine max* (soybean)
Rhizobium loti	*Lotus corniculatus* (bird's-foot trefoil)
Azarhizobium caulinodans	*Sesbania* spp. (e.g. *Sesbania rostrata*)

Sources: "Inoculation of Forage Legumes," University of Kentucky Cooperative Extension Service; "Technical Paper 2: Biological Nitrogen Fixation," FAO; "Legume inoculation in Florida," University of Florida, IFAS.

How to store inoculant

As mentioned earlier, rhizobial bacteria thrive in cool moist conditions. A good rule of thumb, therefore, is to keep the inoculant cool and moist: 20°C/68°F in a tightly sealed

container. Keep out of direct sunlight and away from high temperatures. If you do not have access to refrigeration, bury the inoculant in a sealed container in a shady location [see *EDN* 86-3 for details about this storage method].

Sources of inoculant

Many companies in the USA produce inoculant for common leguminous crops. Some of them ship internationally. Below are a few sources and their contact information. If you know of other international companies selling inoculants we would love to hear about it.

Becker Underwood (www.beckerunderwood.com). This company has international offices in various countries. Visit their website for contact information. It is also an excellent resource for inoculation information.

Another source for inoculants is www.agstore.net.

Correction and Online Resource

In *EDN* 100 we mentioned the availability of CDs of the "Humanity Development Library," which contains a wealth of information. We have since received several requests for copies of the CD. The CD we have to distribute is actually the "Community Development Library for Sustainable Development and Basic Human Needs" v2.1, with 1,785 pubs, 55,000 images, 160,000 pages. As far as we can tell, it has all of the documents that were on the Humanity Library and more.

You can browse both of the Libraries online at: nzdl.sadl.uleth.ca/cgi-bin/library. We also still have copies of the Community Development Library available, for those who do not have good Internet connections. Let us know if you would like one.

ECHOES FROM OUR NETWORK

Drying Moringa during the Rainy Season

Jonathan and Alison Nichols
World Concern/SIM
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We work in Burkina Faso where moringa produces leaves from May/June to October during our rainy season (800-900 mm). Last year we established a moringa plot of about 150 trees and began drying the leaves for powder. The frustrating thing is that the rainy season is very humid, so drying the leaves in the shade is very difficult, possibly taking a week or more of spreading it out (on a plastic mat, tarp or sheet), gathering it in for the rains and the nights, spreading it out again, etc. Another promoter of moringa in Burkina said he has used his gas oven. Though it works, to do it at low temperatures either requires very small batches or lots of turning. Then too, ovens are not affordable by most villagers, and it seems a pity to waste the fossil fuel where there is so much sun. Perhaps others have had similar experiences and might appreciate a village-level technology solar dryer that we have used this year to very good effect.

We start with a woven plastic mat of 1.5 x 3 meters and spread the moringa leaves (most stems removed) 1-3 cm thick. On each side of the long sides of the mat we place two long boards which support two pieces of corrugated metal roofing, just 5-8 cm above the plastic mat. The two short sides are left open to let air pass, and if it is windy, some rocks may be needed to hold the roofing in place (Figure 4).

Depending on how thickly the leaves are spread, and on how sunny or cloudy the day happens to be, it may be helpful to turn the leaves once or twice. In our experience, one day of decent sunshine from 9 am to 3 pm can dry leaves for a kilo of powder. Temperatures under the tin can get above 50ºC, but of course the leaves are still in the shade and the quality of the resulting powder can been seen in its bright green color. From a physics standpoint, the metal roofing blocks the vitamin-destroying UV rays of the sun. The bottom surface of the hot tin dries the leaves both by infrared radiation and by warm-air convection. Black paint on the top surface of the tin could increase both effects.

Our Burkinabé friends say that gumbo (okra) is especially difficult to dry. Our dryer did pretty well drying a batch during two or three somewhat cloudy/rainy days. Next, we would like to try tomatoes and mangos.

The cost of the dryer is not insignificant—especially the corrugated metal sheets (two sheets may cost US$12 here). One sheet might work just as well for smaller batches, or families might share two or more sheets to reduce costs. The benefit against which the cost is weighed is the value of improved nutrition during the dry season, which is difficult to quantify but real nonetheless. [Editors: One could also construct a drying shelf just under an existing corrugated metal roof.]

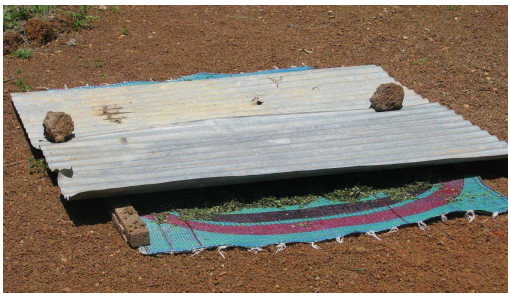

Figure 4: A village technology solar dryer, used effectively in Burkina Faso during the humid rainy season. Photo: Jonathan and Alison Nichols.

Planting Small Seeds

In *EDN* 99, we shared a tip for planting small seeds. Danny Blank, ECHO's farm manager, had this to add: "When dealing with small, small seeds (like carrots) at ECHO, we like to use worm castings that hold a lot of moisture and are 'sticky' compared to the sand that we farm in. The seed can be pressed into a moist worm manure-lined furrow that holds water, holds the seed in

place, and will ultimately contribute to the long term fertility and health of the plant. If worm castings are not available, a high organic "mud" is a nice substitute. Well decomposed organic matter is sticky and has tremendous water holding capacity for germination. This has worked well for us at ECHO."

Dr. Price has used another helpful technique for small carrot seeds in soil that readily dries out. Place a board over the row of carrots. Check every day to see when they just begin to germinate. As soon as you see one or a few sprouts, remove the board. [You can sprinkle sawdust over a newly-planted row to accomplish a similar purpose.]

FROM ECHO'S SEED BANK

Faba bean (*Vicia faba*)

By Sara Hendershot
ECHO Seed Bank Assistant

Faba bean is one of the oldest dual-use food and fodder species. The beans are rich in minerals (calcium, phosphorus) and vitamins. Containing approximately 26% protein, 2% fat, and 50% carbohydrate, faba bean is considered in some regions to be superior to field peas or other legumes as a human food source. It is one of the most important winter crops in the Middle East.

Vicia faba is commonly referred to as ***fava bean, broadbean, horsebean, field bean or faba bean***. It is believed to have originated in southwest Asia or around the Mediterranean and is now cultivated throughout Europe, Africa, Central Asia and the Americas.

Faba bean is a cool season legume, growing well in temperate regions as well as the highland tropics. It can be seeded in early spring as soon as the soil is tillable in temperate areas. More hardy than the garden pea, it will survive temperatures as low as -10°C (15°F). Optimal temperature ranges from 13-27°C (55-80°F). It also grows especially well at high elevations (1200-3500 meters / 4000-11,500 feet) in the subtropics and tropics as a "winter crop." However, it is not well-suited to the humid lowland tropics, where it may flower but fails to set seed. Although faba bean is not a very drought-resistant legume crop, ICARDA (International Center for Agricultural Research in Dry Areas) has developed cultivars with higher water use efficiency. Faba bean requires an average annual rainfall of 700-1000 mm (28-40 inches), will grow in moderate soil types, and is more tolerant of acidic soil conditions than most other legumes.

The large-seeded varieties produce 1 or 2 pods at each node while the small-seeded types can bear 2-5 pods. The pods are up to 18 inches long and contain 3-12 large beans. There are about 15 pods per stalk on the large types and 60 pods on plants of the small-seeded varieties.

This annual crop provides good ground cover during the first 75-90 days of growth, flowers in 80-90 days and produces mature seed at 100-150 days after planting. However, note that the onset of flowering is largely dependent on environmental conditions (temperature, photoperiod), and may range from 1 month to 7 or 8 months.

Faba bean can be grown alone or intercropped with other food crops. A large percentage of world cultivation of faba bean comes from China where it is often intercropped with wheat, cotton or barley. In Ethiopia it is intercropped with pea, while Egyptians grow faba beans amongst their sugarcane.

Faba bean pods can be eaten as a vegetable at an immature stage, cooked or raw. The young, tender beans can also be boiled, but the indigestible skin of the bean must be peeled before eating at this stage. Mature seeds can be baked and eaten like a peanut or ground to be added to soups. Some popular dishes of faba bean include medamis (stewed beans), falafel (Middle-eastern dish made by deep frying the cotyledon paste, added to vegetables and spices), bissara (cotyledon paste poured onto plates) and nabet soup (boiled germinated beans). It can also be used as a coffee extender when roasted and ground. *Caution*: Consumption of immature, partially cooked faba beans or inhalation of pollen can result in a form of anemia known as "favism" for a small percentage of the population genetically predisposed to the condition. The toxic compounds that trigger the onset of this condition can be neutralized by soaking the beans before cooking.

Faba bean also makes excellent animal forage for poultry, pigs or cattle. Faba bean straw, for instance, is also a good feed with high protein content (5–20%) and digestibility (50% of the dry matter). The high tannin levels of the seeds (up to 9%) create a bitter taste when fed raw to animals, but cultivars have been developed with low tannin content (1%) and high digestibility. The seeds can be pulverized and added to a feed ration. The leaves serve as a good source of protein and energy. This legume can also be used as a green manure to improve fertility in marginal soil. Faba bean plays a key role in managing soil fertility as a rotation crop; it is often grown in rotation with cereals, especially with wheat or barley.

It is best to harvest the pods just before full maturity to prevent the pods from shattering and/or rotting. Cut the plants in early morning or late evening to avoid the hottest part of the day. The harvested material can be gathered in small piles and left to dry for a few days. To collect the seeds, thresh the plants with a stick or allow animals to tramp them. Seeds with moisture content of 11-14% can be stored for 2-7

years at 5-10°C (40-50°F) or 1-4 years at 10-20°C (50-70°F).

With respect to nitrogen fixation, faba bean plant roots are effectively nodulated by *Rhizobium leguminosarum.* In a study conducted in several locations in the southeastern Ethiopian highlands, faba bean inoculated with this bacteria fixed between 139-210 kg/ha (124-187 lb/acre) of nitrogen (see previous article in this issue on inoculation of legumes).

Two common fungal diseases, chocolate spot and rust, have caused up to 50% yield losses in Egypt. Faba bean is known to be susceptible to various viral diseases, including bean yellow mosaic virus, bean leaf roll, and broad bean stain virus. However, several new breeds have been developed with resistance to all these diseases.

ICARDA has been selecting lines with improved performance where there are yield-limiting factors such as broomrape (parasitic weed; *Orobanche* sp.) or some of the diseases mentioned above. ECHO received a sampling of these lines from ICARDA in 2007 and is able to provide trial packets, containing a mix of seed of these accessions, to interested members of our overseas network. See the "Seed Policy" section of our technical website (www.echotech.org) for information on registering as a member of ECHO's network. Those interested in conducting a replicated trial with pure lines should contact ICARDA (email: A.N.Akintunde@Cgiar.org; phone: (963-21) 2213433 ext. 2585).

UPCOMING EVENTS

15th Annual ECHO Agriculture Conference (EAC)

Fort Myers, Florida
December 9 to 11, 2008

Please take special note of the December dates for this year's conference. The conference will start on Tuesday morning so we recommend arriving on Monday afternoon.

We have a great line-up of Resource Speakers.

Lowell Fuglie, the man who came up with the wildly popular idea of making moringa leaf powder as a supplement in nutrition centers, currently working in Ghana, will bring us an update on the latest news concerning moringa and the developing world.

Grant Dryden, one of the principle teachers of the Farming God's Way technique in Zimbabwe, will teach the basics of the technique and the philosophy and extent of its adoption.

Laura Meitzner, past ECHO intern and co-author of *Amaranth to Zai Holes* who has taught in Banda Aceh since the tsunami, will speak on a combination of topics including influences of social networks, land tenure, and natural disasters on agricultural efforts.

Ryan Haden, finishing his Ph.D. at Cornell while doing research at IRRI, will bring an update on adoption of the technique of SRI rice production and a perspective on the controversy between practitioners and some scientists about how unique and valuable SRI rice cultivation really is.

Jim Goering has had many significant responsibilities, including heading the World Bank work in Mainland China. He is now an ECHO Board Member and will be bringing a perspective on the big issues of world food shortages, food/biofuel competition, and sweeping economic challenges facing the world, with emphasis on the developing world.

Wayne Niles, career missionary with years in Haiti and now Democratic Republic of Congo, will speak on some amazing things he has seen in reforestation of the Sahel.

Dr. Martin Price, Co-Founder of ECHO, will discuss practical lessons learned as ECHO has grown and developed throughout his 27 years of leadership as CEO and head of our Agricultural Resources Department.

Rick Burnette, founder of the Upland Holistic Development Project (UHDP), will reflect on lessons the UHDP team has learned from 14 years of operating a small farm resource center in northern Thailand.

Dan Gudahl, Senior Program Manager for Winrock International and formerly with Heifer International in Africa, will be our conference wrap-up speaker. He will bring a 40-45 minute wrap-up of the most significant themes, ideas and techniques we have heard at the conference.

The ECHO Agriculture Conference is a networking conference, which means that you—the delegates—are the most important resources. Even though we have filled the morning Resource Speaker slots, we still have opportunities for 20-minute evening presentations (in one of three concurrent sessions at the hotel) and practical, hands-on 60-minute afternoon workshops on our Global Farm. At past conferences, delegates have shared about a project that has worked well; a "good idea" and why it failed or succeeded; a promising plant; etc. Ask yourself, "How can what I share benefit other delegates?" If you are willing to participate, please indicate that on the conference registration form, available online (www.echoevents.org) or by request (phone: 239-543-3246; email: echo@echonet.org). Be sure to suggest a topic for our speaker selection committee to consider.