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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 humankind by using science and technology to help the poor.

Issue Highlights

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ECHO
17391 Durrance Rd
North Ft. Myers, FL 33917
USA
Phone: (239) 543-3246
Fax: (239) 543-5317
echo@echonet.org
www.echonet.org

Resource Rights

By Laura Meitzner Yoder, Ph.D.

Dr. Laura Meitzner Yoder presented on the topic of resource rights at ECHO's Agriculture Conference in December 2008. Several delegates commented that they wished they had heard something similar before beginning their development work. We hope that you, too, will find the information helpful!

Laura, an ECHO staff member from 1994 to 1996, became interested in resource rights issues while working in agricultural development in Indonesia and East Timor since 1998. She found that external encroachment on villagers' land and forest area often threatened farmers' livelihoods more than agronomic constraints to production. She commented that these issues are commonly found on a large scale in peri-urban areas, near protected areas or national parks, and in resource-rich regions—anywhere that a powerful group has interests in controlling access to natural resources. Similar property issues are also found worldwide among villagers and urban dwellers themselves. More information.

Introduction

Can you answer the following questions about access to resources in your community?

- Can those growing crops next to a stream or irrigation channel divert water into their fields whenever they want, or are there rules governing irrigation scheduling? If so, who or what group in the community makes these decisions and settles disputes over water allocation?
- Do individual farmers who improve soil health for permanent cropping run the risk of losing their land to more powerful people once it becomes more productive?
- Can the first people to see a wild beehive in a forest tree claim the right to harvest that wax and honey at some time in the future? How would they make that claim known or visible—putting a mark on the tree, reporting it to a local authority, etc? Once they harvest the hive, do they give a portion of the wax and/or honey to a certain individual or group with other claim to that forest?
- Who is allowed to harvest fuel wood from the forest near the village: village residents only, or also people from nearby villages, or members of an extended family? Do village residents and/or non-residents need to have permission from some local leader to collect fuel wood there? Can people collect only certain classes of wood (for example, fallen branches or dead trees), or other forest products (leaves, vines, fruit)? Are there certain types of trees that are always the special property of an individual leader or clan/tribe? If someone is harvesting fuel wood and sees fruit fallen to the ground, is it permissible to pick up the fruit? If fruit is ripe on a tree, can anyone pick the fruit? Who is responsible for punishing those who break local regulations on wood or fruit harvesting?
- Do people plant, or harvest from, or cut down trees as a way to claim the land under the trees as their own?

Understanding Ownership

These questions deal with concepts of property rights, ownership, and resource access. To answer these questions, you need to understand the ways people claim and own resources in your region. Ownership defines *who* can do *what* with different resources. For example, the rights to walk across a field, to harvest fuel wood or forest fruits, to use water for irrigation, to plant or cut trees, to graze a herd, to give permission to use land for annual

crops, to sell/lease land, or to install a fence are all governed by local norms that are often invisible to outsiders. In every circumstance, different individuals are involved in making and enforcing regulations on these actions.

This article will help you identify the different kinds of property systems that exist, and how you can learn about them in your setting. Understanding local principles of resource ownership before building permanent buildings or planting trees for your project can help you avoid mistakes and future misunderstandings.

Property claims exist everywhere. Even in places without any government intervention in identifying owners (through land titling, for example), local people have strong ideas and well-defined knowledge about ownership and access rights associated with various resources. It is important to realize that different legal systems, regulations, or norms operate at the same time (a situation called *legal pluralism*); people may have to consider more than one source of authority when they make decisions about resource use. For example, there may be government regulations about forest use, but there are also traditional, customary, or religious leaders who set rules about access to that same forest. In many rural areas, such customary tenure is the most important system determining resource rights.

Property rights exist at many different social levels (individual, nuclear or extended family, clan or tribe, larger group, etc.), and at different levels of "formality" or official status. For example, an urban property may have an individual owner and a government-issued (formal) title. For this kind of property, it can be simple and straightforward to understand the exact identity of the officially recognized owner (by looking at the title) and the means to transfer rights to that property (through sale or rental). Understanding rights to use areas owned by larger numbers of people—extended families, clans, or certain ethnic groups—is much more complex. For example, access rights to grazing or fishing areas vary seasonally, or according to one's clan or tribal status. There are usually local regulations concerning how group members and non-group members can use the land and its water or plant resources, and these are often not recorded on paper. Non-members may have access to the land if they contribute to some group event or pay someone for use rights. Resource rights at this level are likely regulated by local leaders rather than a recognized government authority, and are called "informal" or "customary" or "traditional" rights.

What are "Commons"?

One very important concept for many *EDN* readers is that of "commons," which are resources held, owned, or managed collectively by many different users, often from different communities. Many of the world's poorest and most vulnerable people depend on common resources for a very large part of their livelihoods. These people depend on collecting fuel wood, medicines, or other wild foods or trade items in community forests for their basic subsistence. They use common hunting, grazing, or fishing areas that are shared

Figure 1: Irrigation channel beside a farmer's field in Haiti. Water use is often governed by local norms that may not be immediately obvious.

with other groups, often according to well-developed local regulations governing timing or length of use, species and quantities that can be taken, and other factors. Newcomers to an area may not know what these customary regulations are, or even be aware that they exist.

Learning about these norms can take quite some time, for the following reasons:

- they are usually known only by local residents or group members
- they may be unwritten
- they change and adapt over time
- they may involve learning about and dealing with layers of customary authorities (who do not have an office or wear a uniform!), and they may be strongly linked to the relative social power of various people involved in using that resource.

For those interested in learning about common resource management, a good place to start is the International Association for the Study of the Commons (Common Property) (www.iascp.org), which has a worldwide network and hosts a digital library and bibliography with more than 57,000 references about common resources.

Commons are usually *not* "open-access" for just anyone to use however they choose—in most cases, there are well-defined, existing local regulations about who can use certain resources in which ways. For this reason, working with communities to improve their resource use or allocation means getting involved in the *institutional* aspects of development, including leadership, membership, and group dynamics, often requiring skills including conflict management and negotiation, that extend beyond the technical skills of agricultural projects.

In some settings, national government or international programs have tried for many years to extend individual titles to agricultural land, much like the individualized urban land title described earlier. These projects were often undertaken with the assumption that farmers had to have government-recognized formal property titles to give them the tenure security needed to make permanent investments on their land.

What these projects often ignored was that in many (especially rural) areas, customary institutions were already providing adequate tenure security. Many of these rural land titling projects also failed because they were too expensive to maintain beyond the initial round of titling. Complex collective resource management and dispersed, rotational swidden land use were very difficult to translate into individual land titles, and "formalization" through land titling could disadvantage certain vulnerable groups, including women, immigrants, or certain social groups who may have customary rights to use, but not to own, certain resources. Sometimes, informal, customary arrangements are more favorable to vulnerable groups than formal or well-defined rules that require literacy, cash, or other resources or skills to navigate.

In 2003, a World Bank report revised its decades-long policy on customary tenure of "subdividing the commons" (World Bank 2003:62). Instead of trying to replace existing customary institutions, the new policy encouraged working with and reflecting customary institutions in project design. Other programs (like CAPRi; see Mwangi 2006) have encouraged lending agencies to do several things: (1) promote land-related investments on areas regulated by customary law; (2) focus more on *use rights* and *access* than on formal ownership; (3) support rather than fragment group-based resource management; and (4) strengthen the institutional skills in negotiation and conflict resolution that are needed for effective commons oversight.

Resource Rights in Your Setting

Learning about resource rights in your particular setting will take commitment to understanding complex, situation-specific issues that change over time. The following points give you a place to start learning about these issues where you are.

Local resource authorities. One of the important starting points is to identify the people in your community or region who are resource gatekeepers: people who have the power to grant or to deny access to a resource. Anticipate that there may be layers of *existing* authorities and social institutions who should be consulted about any intervention/project. When learning about the domain and extent of these people's authority, be aware that some have very resource-specific jurisdiction; for example, one may regulate sandalwood or teak harvest, but another may have oversight of springs and irrigation matters.

Factors that determine ownership/access status. It is important to learn about how one group's access rights may be different from another group's rights. For example, in one East Timorese village, I learned that descendants of a group that settled in that village after a political conflict ninety years before did not have the right to permanently own land—so even though they had the same family name as others in the village, I had to know the migration history of a particular household to know whether they were eligible to own (or inherit, sell, or buy) land in the customary system. In another area, you may need to understand past political allegiance to understand how different groups have access to resources now. There may be issues of caste, clan, or migration. One way to understand this is to make notes of the different claims of various groups, and to ask why one group has rights that another group does not. For example, you might find that 2 out of 15 total clans do not have rights to use palm thatch from a certain forest. What makes them different? Try to determine what affects membership, and who is excluded from resource ownership or access. You can learn about, document, and advocate for vulnerable people's access to resources.

How do people acquire new rights? Ask how people came to own or use the land they have. Did they simply settle there? Did they have to cut old forest, or simply start farming, or make some kind of enduring modification (like terraces or hedgerows), to secure their claims? Did they have to get permission from some local leader? If someone plants a tree, who owns that tree—the person who plants, his/her extended family, or the landowner? Does planting a tree on empty land effectively "claim" that land under the tree? Is there some other labor input that confers ownership? Use maps to understand different people's knowledge about domains and resources, and to discuss access.

Misunderstanding this factor has caused failure in countless tree-planting projects around the world. I know of a very ambitious, agronomically sound international project in which youth planted trees on a prominent bare hillside within view of the capital city; one morning, all the trees had been uprooted by the landowner, who felt that the outsiders' tree-planting was an action meant to "steal" his land. Tree-planting is a long-term investment, so take time early on to determine the possible ownership effects of planting trees in a given location.

Study existing resource conflicts. One of the best ways to understand issues of ownership is to learn about a particular conflict in great detail. Perhaps you heard that two villages have fought about access to a bamboo forest for decades; if you learn why this problem exists (from the different sides), you will probably uncover some of the points that affect conflicts over access to other resources as well. If your work involves resource development (e.g. building a structure, or some other kind of investment), anticipate that there will be property disputes, and consider who will be able to help you deal with these matters.

Resource-specific rights. Every resource has property rights that are specific to that resource. For example, in many areas of Southeast Asia, someone who buys land might not also own the trees that have been planted on that land. Tree ownership does not pass from one person to another by sale, but only by inheritance. Planted trees (and their leaves, fruits, or timber) remain the property of the family that planted them, even after the land on which the trees stand is sold to someone else. In western New Guinea, a hunter pursuing a wild deer can follow the deer across clan boundaries, but a hunter pursuing wild pigs does not have the right to kill a pig on another clan's land. Harvesting rights are different for various types of trees:

for example, in one area, tamarinds or guavas may be available to anyone who wishes to pick them, but durian or coconuts are considered individual or family property. These differences make it necessary to clarify which resources in a forest, for example, are individually or communally owned, and those which are considered common property.

Conclusion

Learning about resource rights is an important part of development work. Since many smallholder farmers and landless people depend heavily on common resources and use communally owned areas for their livelihoods, understanding resource access is important in identifying and implementing useful interventions. There are usually layers of existing authorities and social institutions that should be consulted before making agricultural improvements. Ask yourself, "Who might lose if this program is successful?" Keep in mind that customary arrangements may govern how people negotiate access to various resources, and sometimes these arrangements are more favorable to vulnerable groups than more formal property regulations. Understanding local resource rights can enable you to document and to advocate for justice in resource access.

If you wish to correspond with Dr. Meitzner Yoder on the topic of customary ownership issues and common resource use/access, feel free to send an e-mail to echo@echonet.org (with "Resource Rights" in the subject line), and we will forward your message to her. You can also post comments from the online version of this article.

Footnote: Elinor Ostrom just won the 2009 Nobel Prize in Economic Sciences for her lifetime of work on the commons, especially the role of cooperation in resource management. Dr. Meitzner Yoder commented, "The study of institutional aspects of commons resource management has been marginalized from mainstream economic development theory for a long time. Dr. Ostrom's winning this award is a significant step toward broader recognition of people's potential to collaborate in resource management to produce positive results. See the IASC(P) website for her publication list and more information on her work. She was a founding member of the IASCP."

References and Resources

CAPRi: CGIAR Systemwide Program on Collective Action and Property Rights (www.capri.cgiar.org/pubs.asp)

IASC: International Association for the Study for the Commons (www.iascp.org)

Mwangi, Esther, ed. 2006. *Land rights for African development: from knowledge to action*. Washington, D.C.: Consultative Group on International Agricultural Research (CGIAR) (www.capri.cgiar.org/pdf/brief_land.pdf)

World Bank. 2003. *Land Policies for Growth and Poverty Reduction*. Washington, D.C.: World Bank. Downloadable; do a web search, then open the document and "Save to computer."

Effect of Sprouting on the Nutrition of Grain and Legume Seeds

By Dawn Berkelaar

Sprouting seeds for food involves germinating them by first soaking them, then putting them in a moist, warm environment for a few days, rinsing them at least twice a day. Over the years, sprouting has been mentioned to us as a beneficial and easy method of increasing the nutrition of cereal and legume seeds. We have wondered about the actual benefit of sprouting. Does it change the nutrient content of seeds significantly?

Finney's Review

We found some answers in a book chapter called "Effect of Germination on Cereal and Legume Nutrient Changes and Food or Feed Value: A comprehensive review" by P. L. Finney (see end of article for full reference). With summaries of more than 300 scientific studies about the effects of germination on nutrient changes, it provided a valuable glimpse into the nutritional impact of sprouting. In this section, we share some highlights from Finney's article.

Vitamin C. A deficiency of vitamin C results in scurvy, with symptoms that include swollen, bleeding gums; loss of teeth; sore joints and anemia. Dry, ungerminated cereals and legumes contain almost no vitamin C. Germinated seeds, on the other hand, can have very significant vitamin C content—more than enough to protect against scurvy. In one study, severe cases of human scurvy were cured more quickly with 3-day germinated haricot beans (small white beans; *Phaseolus vulgaris*) than with 4 oz of fresh lemon juice. Many different sprouted grains and legumes protect against scurvy (e.g. mung beans, sprouts of which compare to citrus in terms of vitamin C activity; cowpeas; rye; barley; wheat; oats; rice; broad beans and peas). Sprouted sorghum and soybeans seem to be exceptions in that they do not have much vitamin C. Finney's article referred to an Indian famine during 1938-1941 that led to scurvy and malnutrition. These "were essentially eliminated by the [distribution] of germinated grain. In fact, when the germinated grain was discontinued, the disease reappeared, and thereafter disappeared when the germinated grain was reintroduced as a [preventative measure]. As a curative and preventative measure, over 200,000 people received one ounce of germinated grain biweekly." Some authors have reported that more vitamin C is produced when sprouts are grown in light.

B Vitamins. B vitamins are important for cell metabolism and proper function of the immune and nervous systems. Sprouting seeds generally increases levels of B vitamins:

- Sprouting doubled the content of *thiamin* (vitamin B_1) in mung beans, but not in barley.
- Sprouting greatly increased *riboflavin* (vitamin B_2) content. "Invariably sprouting increased riboflavin content, generally by a few hundred percent." One serving of pea

and bean sprouts was found to contain 1/3 of the recommended daily allowance of riboflavin.

- *Niacin* (vitamin B_3) in cereals is bound and nutritionally unavailable. A deficiency of this vitamin causes pellagra, with symptoms of fatigue, sore skin and mental disorders (see *EDN* 103 for more information). In his article, Finney concluded, "Germination from 2 to 5 days invariably enhances total niacin content of edible cereals and legumes." (In general, cereals contain about double the niacin that most legumes do. Peanuts, however, contain about three times as much niacin as most cereals.)
- Legumes typically contain about three times as much *biotin* (vitamin B_7) as cereals. "Two to five days of germination doubles the biotin content of edible cereals as well as legumes."
- *Pyridoxine* (vitamin B_6). Levels increased during germination (by 50 to 100%) in wheat, barley, corn, oats, soybeans, lima beans, green eye peas, mung beans and peas.
- *Folic acid* (vitamin B_9; especially important during pregnancy for proper development of a fetus). Sprouting seemed to reduce folic acid content of pulses/legumes, but increased the folic acid content of grains.

Other Vitamins

Carotene (the precursor to vitamin A; the article commented that "the carotenes themselves have no intrinsic vitamin A activity but may be enzymatically converted into the active form of the vitamin in the liver or intestine."). Germination of legumes and cereals seems to (on average) double total carotene content.

Vitamin K increased dramatically after germination, by a factor of 25 when grown in the light, and by a factor of around 10 when grown in the dark.

Other Nutritional Changes during Sprouting

Cereals and legumes contain phytate, which binds phosphorous and makes it unavailable to the body. Phytate also interferes with the metabolism and absorption of minerals such as iron, zinc and calcium. The enzyme phytase, activated by germination, can release the phosphorous from phytate. After two or three days of germination, phytase activity increased more than 200%. Phytates can also be reduced by 50 to 75% in small white beans by incubation in warm (~55ºC/131ºF) water or air. In wheat varieties, phytate content was lowered by 40 to 60% after five days of germination.

Iron. In legumes, germination increased available iron. (Note that germinating seeds may absorb minerals from hard water used for soaking and rinsing seeds. In a study in Peking, mung beans and soybeans were sprouted in hard city water containing calcium and magnesium salts. The resulting sprouts had a large increase in calcium levels. By contrast, if distilled water is used to soak and rinse seeds, minerals may be lost.)

Lysine. In many grains, lysine (an essential amino acid, often lacking in cereals) has been shown to increase by 10 to 50% with germination. In legumes, amino acids do not seem to change very much in response to germination.

An Example from a Human Study

Finney wrote about a study investigating "the effects of feeding scientifically based, nutritionally sound meals and snack foods to young children (average 3 ½ years old) who were underfed. [Before receiving the nutritious meals,] those children suffered gross growth retardation and weighed about as much as average, healthy one-year-old children. In the feeding trials, one main protein calorie dish was conjee, a cereal:legume mixture in which millet and chickpea seeds were sprouted, partially air dried, roasted and ground. The cereal:legume flours were then cooked in water for a few minutes to form a thick gruel to which might be added milk and salt. For another meal dhokla was given. This was a fermented cereal:legume mixture with added chopped greens that was steamed in greased pie plates for about 20 minutes, cooled, cut into pieces and seasoned. . . .Without going into specific details, those foods were well accepted and tolerated by children. The weight gain and biochemical status of those poorly nourished children, after receiving diets based on locally available foods but subjected to simple processing using ordinary culinary procedures, were comparable to those of upper class children!" Riboflavin content of the millet doubled with sprouting, and niacin content increased by 20%.

Finney's Conclusion. Finney's article concluded, "If the food value of germinated seeds is to be judged by their content of vitamins and readily available amino acids, then it appears that the common use of sprouts in the diets of oriental people rests on a sound nutritional basis and should be introduced on a wide scale….In summary, based (1) on nearly 100 years of chemical studies, (2) on about 70 years of corroborative rat and other animal feeding studies, (3) on further corroboration by a few well documented human feeding studies, and (4) on hundreds and in some cases thousands of years of experience by millions of people, it is concluded that carefully controlled, optimal germination of edible cereals and legumes is capable of significantly alleviating today's food problems and avoiding tomorrow's food needs."

Sprouting and Enzyme Inhibitors

The book *Nourishing Traditions* points out a further benefit to sprouting, in addition to the increase in vitamin content and neutralization of phytates. "Sprouting. . . .neutralizes enzyme inhibitors that can [otherwise inactivate] our own enzymes in the digestive tract. Edward Howell, author of *Food Enzymes for Health and Longevity*, describes enzyme inhibitors as follows: 'In nature, seeds sometimes must rest or hibernate for months or years before conditions become satisfactory for them to grow. Enzymes are present in the resting seed but are prevented from being active by the presence of enzyme inhibitors. Germination neutralizes the inhibitors and releases the enzymes. Enzyme inhibitors are part of the seed machinery and serve a purpose. But these inhibitors are out of place in our bodies. They could stop our own enzymes from working.'"

A Few Tips and Cautions about Sprouting Seeds

The actual process of sprouting is straightforward, and detailed instructions can be found on the internet. Here are very basic instructions. Add seeds to a glass jar (fill it 1/3 full for larger seeds; maybe a little less for smaller seeds). Add clean, filtered water, and let the seeds soak overnight. The next morning, pour off the water and set the jar upside down at an angle. Rinse the seeds twice a day (more often in hot weather), being careful to drain the jar well after rinsing.

Figure 2: Mung bean sprouts, ready for consumption.

Jerry Henkin has been sprouting seeds since 1962. In the past, he has encouraged people at ECHO to sprout seeds. In addition to the usual instructions for sprouting, he recommends immersing sprouts in water after three or four days of growth, to remove hulls and ungerminated seeds that can otherwise result in a rancid odor.

Use Clean Seed. Be careful to make sure that the seeds you sprout are free of fungicides or other chemicals. In general, seeds meant for human consumption should be clean enough. Others (e.g. seeds for planting) might not be.

Use Clean (but not Distilled) Water, and Drain Sprouts Well. If sprouts are not properly drained, the standing water can make the sprouts turn rancid. Bacterial contamination is also a possibility (from the seeds, the container, or the water). Filtered and disinfected water should be used (see *EDN* 90 for ideas on how to treat water), but distilled water is not recommended, as noted previously. Important nutrients apparently leach from the cotyledons when distilled water is used. Using water that contains inorganic salts is preferable, and even seems to enhance vitamin C production in sprouts. In addition, mineral salts and other water soluble nutrients in hard water (e.g. calcium) can be absorbed by germinating seeds, actually increasing their nutritional value.

Effect of Temperature on Sprouts. Temperature can affect the growth and nutrient composition of sprouts. For sprouts, more shoot growth than root growth is typically desired. This seems to occur at temperatures of 28ºC or higher.

Sprouts are Not Only Eaten Raw. In some locations, few fruits and vegetables are eaten raw due to concerns about bacterial contamination. If you are in a similar situation, it does not mean that you cannot benefit from growing sprouts. In fact, the book *Nourishing Traditions* points out that raw sprouts can contain irritants, and as a result recommends that sprouts be lightly steamed before eating, or that they be added to soups and casseroles. Seeds tend to cook more quickly once they have been sprouted.

Seeds to Avoid. Almost any seed or grain can be sprouted. A few that are difficult to sprout are flax and oat seeds. Irradiated seeds are dead and will not sprout. Despite their popularity for sprouting, *Nourishing Traditions* recommends against sprouting alfalfa seeds, because the resulting sprouts can inhibit the immune system and also contain a potentially toxic amino acid called canavanine. We have also read that it is best to avoid sprouted sorghum, as it can be poisonous.

Conclusion

In effect, it seems that sprouting turns seeds from a carbohydrate source (containing mainly energy in the form of starch) to a vegetable source (with consequent increase in vitamins and minerals). Though care must be taken to use clean water, sprouting can be an important way to meet dietary needs for vitamins and minerals, especially in seasons and situations when fresh vegetables are difficult to obtain.

References

Fallon, Sally, with Mary G. Enig. 2001. Nourishing Traditions, Revised 2nd Edition. New Trends Publishing, Inc.

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Alternative Germination Mixes for Starting Transplants

Results of a trial conducted by Terri Lynn Paulson, Trey Nation, Dr. Tim Motis, Timothy Watkins and Andrew Cotarelo

Introduction

We at ECHO are sometimes asked what we recommend for a germination medium in situations where seeds or seedlings need to be started in pots or plastic sacks before going out to the field. This past summer, we conducted a trial at ECHO to make and evaluate potting mixes that could serve as effective substitutes for purchased potting mediums, since ready-made potting mixes are typically unavailable, impractical or expensive in many developing countries. Nurseries usually resort to developing some ratio of topsoil, sand, and organic material (e.g. animal manure and/or compost) to serve as a potting medium. For our trial, we sought to use ingredients that would be accessible in many areas of the developing world. Based on some common potting mix recipes, we developed a series of recipes using the following components: sand, cow manure, compost, and both charred and un-charred rice hulls.

The trial was conducted in the ECHO greenhouse, where seedlings could be monitored and watered regularly. Using maize (*Zea mays*) as an indicator crop, our goal was to identify one or more potting mediums that would prove

suitable for a healthy, uniform population of seedlings for use as transplants.

Materials and Methods

We chose the following twelve potting mix recipes with which to conduct our experiment:

1. 100% Fafard 2 Mix (Control 1; www.fafard.com/index.php?p=134)
2. ECHO-modified Fafard 2 Mix (Control 2; contained soluble fertilizer, dolomite (lime containing calcium and magnesium), and mycorrhizae)
3. 4:1 Manure, Sand
4. 2:1 Manure, Rice Hulls
5. 2:1 Manure, Charred Rice Hulls (burned slowly in a pile with little or no flame)
6. 4:1 Compost, Sand
7. 2:1 Compost, Rice Hulls
8. 2:1 Compost, Charred Rice Hulls
9. 1:1:1 Manure, Compost, Charred Rice Hulls
10. 2:2:1 Manure, Compost, Sand
11. 1:1:1 Manure, Compost, Rice Hulls
12. 1:1 Manure, Compost

Each recipe was replicated four times. For each replication, 25 maize seeds were planted individually in cells of a planting tray, one inch (2.5 cm) deep. Trays were arranged in the greenhouse using a randomized block design, and were uniformly watered on a daily basis. Except for the ECHO-modified Fafard 2 Mix, no additional fertilizer was added to any mixtures.

Two weeks after seeding, we counted the number of plants in the center nine cells of each maize replication, rated leaf color, and measured plant height (germination, color and height data are shown in the issue Supplement).

We then removed the transplants from the trays and washed the soil off of the roots so that the plants could be weighed. We recorded the total (fresh) weight, as well as total above- and below-ground weight for each replication.

Results and Discussion

Total biomass serves as an overall indicator of maize growth. The best maize growth, as indicated by total biomass, occurred with the ECHO-modified Fafard 2 Mix (Table 1). Interestingly, this mix resulted in better plant growth than the pure Fafard 2 Mix, indicating that the seedlings responded favorably to the amendments added by ECHO staff.

Of the alternative potting mixes, recipe 9 (1:1:1 Manure, Compost, Charred Rice Hulls) produced the most seedling biomass. Recipe 9, as well as recipes 10 (2:2:1 Manure, Compost, Sand) and 12 (1:1 Manure, Compost), all resulted in healthy seedlings with similar total weights as with pure Fafard 2 Mix. Each of these mixtures contained both manure and compost and resulted in more seedling growth than mixtures with just one or the other of these ingredients combined with sand or rice hulls.

Mixtures containing charred rice hulls did quite well. However, un-charred hulls seemed to allow the mixture to dry out rapidly, so that fewer seeds germinated (data are in issue Supplement). Those that did germinate showed nutrient deficiencies, likely because the high carbon to nitrogen ratio of the un-charred rice hulls made nitrogen inavailable.

Conclusions and Recommendations

1) Considering that seedling growth was best with ECHO-modified Fafard 2 Mix amended with soluble fertilizer, dolomite (lime containing calcium and magnesium) and mycorrhizae, other mixtures would likely be improved by these amendments. This could be an area for further experimentation.

2) Combining materials (e.g. manure and compost) seems to increase the likelihood of obtaining a beneficial combination of nutrients/fertility and soil structure.

3) When using an amendment with a high carbon to nitrogen ratio, such as un-charred rice hulls, consider how well the resulting mixture retains moisture and what possible implications it will have on resulting nutrient availability to seedlings. High-carbon, woody materials can decrease fertility for a time as the microbes breaking them down tie up nutrients to sustain themselves at the expense of plant uptake.

4) This experiment was not exhaustive. For instance, we did not experiment with topsoil. Please let us know of your findings if you experiment with other recipes and ratios.

Table 1: Results of germination mix trial, showing total mass, root mass and shoot mass of maize plants grown in each type of mix. Top alternative performers are shown in boldface type below.

	Total Mass (g)	Root Mass (g)	Shoot Mass (g)
100% Fafard 2 Mix	44.8	20.8	24.0
ECHO-modified Fafard 2 Mix	66.8	20.3	51.5
4:1 Manure, Sand	23.0	7.5	15.5
2:1 Manure, Rice Hulls	9.5	4.4	5.1
2:1 Manure, Charred Rice Hulls	25.8	8.8	17.0
4:1 Compost, Sand	15.5	10.0	5.5
2:1 Compost, Rice Hulls	17.8	11.0	9.5
2:1 Compost, Charred Rice Hulls	32.5	12.5	20.0
1:1:1 Manure, Compost, Charred Rice Hulls	**49.3**	**17.3**	**32.0**
2:2:1 Manure, Compost, Sand	**38.0**	**13.3**	**24.8**
1:1:1 Manure, Compost, Rice Hulls	28.8	12.0	16.8
1:1 Manure, Compost	**41.8**	**15.3**	**26.5**
P value*	<0.001	<0.001	<0.001
LSD value*	12.8	5.0	9.1

*Significant differences between values within a column exist if the corresponding P value is equal to or less than 0.05 (5 % level of significance). Within a column, any two values are statistically different if the difference between them is greater than the corresponding least significant difference (LSD) value.

BOOKS, WEBSITES AND OTHER RESOURCES

Important Resources about Trees of Haiti

Bwa Yo: Important Trees of Haiti by Joel Timyan, a 418-page book, is now available on the Internet at the USAID Development Experience Clearinghouse (DEC). An electronic PDF copy of the book can be accessed by clicking on the link pdf.usaid.gov/pdf_docs/PNACA072.pdf

Mr. Timyan shared that the DEC site also contains other valuable documents about trees in Haiti that can be accessed by clicking on the link http://dec.usaid.gov/.

Timyan added, "I also have compiled a rather complete bibliography of the scientific literature covering forestry, botany, zoology and conservation biology in Haiti as well as the rest of the Caribbean. This is of immense value to students and practitioners in natural resource management." If you would like to obtain a copy of Timyan's document, send us an e-mail request and we will send it as an attachment. The document is over 500 pages and is 2.4 MB in size.

FROM ECHO'S SEED BANK

Seeds of a Warm-Weather Carrot to Try

By Tim Motis

While supplies last, we are making available 'B8524' carrot seed that we are trialing at ECHO, and that you may wish to experiment with as well. The seed was sent to ECHO by Dr. Philipp Simon, a USDA carrot breeder at the University of Wisconsin. In correspondence with Tim Motis, Dr. Simon wrote, "We have identified a seed supply of a carrot that I think will be applicable in warmer climates. We have an adequate supply to provide100 packets of carrot B8524, which has good quality and nematode resistance in our evaluations."

Carrots are normally biennial (life cycle completed the second year after planting seeds) and require a period of cold temperatures (vernalization) for flowering and subsequent seed production to occur. So any variety that readily sets seed in a single growing season in warm climates would be of interest to those working with small farmers in the tropics, especially those with little access to seeds beyond what they can save themselves. When asked if B8524 sets seed within a single growing season (as does the 'Uberlandia' variety ECHO has and continues to supply), Dr. Simon replied, "I think the carrots should seed as readily as Uberlandia. The answer to this question is where we can really use your input and observations. This is becoming a much larger question for much of my carrot breeding program now, so your feedback will be very valuable."

Figure 3: Carrot seed. Photo by Tim Motis.

We encourage our network members to request a complementary packet of B8524. We also suggest that you request a packet of 'Uberlandia' so that you can compare it to B8524. 'Uberlandia' readily produces seed, but the shape of the carrot is quite variable. If you request and grow out either or both varieties, please let us know your results (email echo@echonet.org and write Attn: Seed Bank Manager in your email). Along with a description of the climate, your comments on overall crop vigor, carrot shape and taste, as well as observations on flowering/seed production would be especially helpful. With each mailing of B8524 carrot seed, we will also send an evaluation form that Dr. Simon provided. We will compile the results for Dr. Simon, to better enable him to develop lines of carrots suited to the tropics.

Although this line of carrot is noted for its ability to grow in warm weather, it is still advisable to plant the seeds during the cooler part of year if you are located close to the equator. Remember that carrot is a cross-pollinated crop, so two varieties growing close together and flowering at the same time will cross. Depending on your purposes, this may not be a bad thing. In this case, for instance, an 'Uberlandia' and B8524 cross could result in an improved line of 'Uberlandia'.

Dr. Simon sent some hints for growing carrots. You can read them in the online Supplement.

PLEASE NOTE: At ECHO we are always striving to be more effective. Do you have ideas that could help others, or have you experimented with an idea you read about in EDN? What did or did not work for you? Please let us know the results!