EDN ECHO Development Notes

January 2009
Issue 102

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

NOTE: Link to extra material related to this issue from the web version of *EDN* 102.

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

Can a Consensus be Reached on the Benefits of SRI?

By Ryan Haden
Ph.D. candidate; former ECHO intern

Rising food costs

Rice has been featured prominently in the news lately. The price of rice has more than doubled over the last few years, and the world's poor are feeling the crunch. While a multitude of factors have contributed to this price hike, the most important is that the demand for rice is increasing faster than production. The world once again needs to place a priority on increasing rice production. Unfortunately that is easier said than done in the post-Green Revolution world.

In the past, production was increased either by allocating more land to growing rice or by increasing the yield per hectare, The first option has an immediate impact on production, but suitable land that can be converted to new rice paddies is becoming increasingly hard to find. As a result, most current efforts have been aimed at boosting yields through improved varieties or better agronomic practices. Despite these efforts, average yields in the world's most important rice growing regions have begun to plateau. Water supply in many areas limits increased production and may be polluted. Inputs like fertilizers and fuel are becoming too costly for most poor farmers, and their overuse by others puts further strain on the environment. In the face of such challenges there is only one viable option. Rice farmers must produce "more with less."

The System of Rice Intensification

In 2001, *EDN* 70 featured an article titled "SRI, the System of Rice Intensification: Less Can Be More," which described a new approach to rice production that its advocates claimed could help achieve this goal. Since that article was first published, a lot has happened in the area of rice research and extension. Over the last 7 years, my work and studies on rice, which I began as an ECHO intern, have taken me across Asia and allowed me to see first hand the activities that are taking place—both in farmers' fields and on experiment stations. As a result, staff at ECHO thought it was time for an update on SRI.

Given the thorough coverage of SRI in *EDN* 70, 74 and 77, I assume that most of you are familiar with the basic tenets of the approach. [Editors: you can link to these articles from the web version of this issue.] Table 1 (page 3) compares SRI with "conventional" lowland rice production. For those willing to slog through the scientific literature I also recommend reading both Stoop et al. (2002) and Dobermann (2003) for various views on the topic. These authors cover at length what I can only address briefly in this article. Since *EDN*'s target audience includes mainly those working in rural development, I try here to focus on the issues that directly impact small farmers. That said, I do touch briefly on a few of the theoretical issues that have been raised.

Are SRI yields better than what farmers get normally?

In many cases the answer to this question has been yes. In fact there is a growing consensus among governments, NGOs and researchers that SRI can increase rice yields ***relative to existing farmer practices***. A recent study published by researchers from the International Water Management Institute observed that adoption of SRI practices by farmers in West Bengal, India, improved yields by 32% and increased net returns by 67% (Sinha and Talati, 2007). The World

Figure 1: A family in Indonesia planting rice according to SRI principles.

Wildlife Fund, which has helped sponsor SRI dissemination in India, reports that they see grain yields increase by an average of 20-30% with SRI methods. I have personally witnessed similar yield gains by many farmers in West Java, Indonesia. There are also instances where improvements with SRI have been even higher, in some cases doubling or tripling grain yield over existing farmer practices. This usually happens when farmers' yields are notably low to begin with. For example, dissemination of SRI in Myanmar via the Farmer Field School approach increased average rice yields from 2.1 to 6.4 t/ha among the 612 farmers studied (Kabir and Uphoff, 2007). These are not record breaking yields, but the gains certainly make a big difference to farmers and their families.

The main problem is that "farmer practices" often fall far short of the optimal practices recommended by scientists, particularly in the areas of soil, water and pest management. Rice has always been a crop that responds well to intensive management. The practices prescribed by SRI—such as planting in straight rows, thorough weeding, addition of manure or compost and, in certain situations, younger seedlings and intermittent irrigation—all have a sound agronomic basis. In some places they may already be part of the local recommendations. It is also true that when a support system is established to promote SRI practices, the improved access to information, seed, and credit can also positively impact yields, irrespective of SRI techniques. This is all good news for farmers, but has confounded accurate comparisons in at least a few NGO reports. Generally speaking, the SRI approach amounts to improvements in rice management over usual farmer practices. Therefore, it should come as no surprise that SRI helps to close the gap between what is normally harvested from farmers' fields and what is possible given better management.

Are SRI yields better than what is possible in the conventional system?

This is where the real battles have been fought between advocates of SRI and the conventional system recommended by many in the international research community. Some of the early literature on SRI reported nine cases of extremely high rice yields in Madagascar ranging from 15-23 t/ha, figures which were circulated widely in the NGO literature as well as by *EDN*. Some hailed this as evidence that "synergy" between SRI's practices may have unlocked previously untapped yield potential in the rice plant, essentially allowing the plant to exceed the hypothesized yield limits. However, many in the scientific community were considerably more skeptical and a few expressed serious doubts that SRI could live up to these claims.

> *…the most interesting…for me is the possibility that low input systems like SRI have the potential to rival the productivity of conventional systems, which are often overly dependent on costly fertilizers and pesticides.*

In the field, grain yields of 13-15 t/ha are sometimes achieved in Australia and China using modern conventional methods, which shows that yields in the 15 t/ha range are already possible in some locations. Theoretical models which take into account how the rice plant harvests sunlight and converts it to both biomass and grain suggest a maximum of 18.5 t/ha in temperate climates and around 12.5 t/ha in the tropics. Thus, most experts feel that the largest yields reported for SRI are highly unlikely. I recommend that we be wary of such high yield figures for SRI, particularly when they are not accompanied by detailed methods. We should also be very careful in how we report them in our publications. Small-scale farmers in the tropics are unlikely to ever see yields in this range, so quoting such figures only diminishes the more modest but real improvements that can be seen with improved crop management, be it via SRI or conventional methods.

So to answer our initial question directly: right now there is not much firm evidence to support the claim that SRI offers a significant yield advantage over the conventional approach, assuming optimal water, nutrient and pest management practices are being used. That said, the most interesting question that the SRI debate raises for me is the possibility that low input systems like SRI have the potential to rival the productivity of the best conventional systems, which are often quite dependent on costly fertilizers and pesticides.

Input Dependence vs. Self Reliance

One of the major barriers to technology dissemination and poverty reduction is the economic isolation which stems from poverty itself. People caught in this "poverty trap" have been largely by-passed by the agricultural innovations produced in recent decades. This is particularly true for things like fertilizer, fuel, and pesticides, since these inputs have prices that are driven by volatile international markets. The typical approach to breaking this cycle of poverty has been to subsidize inputs or improve access to credit so that poor farmers are less isolated from beneficial new technologies. Unfortunately the ability of government and NGO initiatives to make these technologies more affordable is usually constrained by funding.

Given these limitations, an alternate approach is to develop and disseminate technologies like SRI which foster greater self-reliance and less dependence on external inputs. For example, when Indonesian farmers faced rising costs for urea following the 1997 Asian financial crisis, some shifted to SRI and the local production of compost as a means of reducing fertilizer costs. I have worked closely with these farmers, and after ten years many are still practicing modified versions of SRI and are increasingly involved in farmer-to-farmer training and outreach. Moreover, when fertilizer prices returned to affordable levels, farmers did not stop producing and using compost, but rather incorporated mineral fertilizers into their regime as needed. (Realistically, it is often difficult for farmers to supply enough N to sustain high yields using compost alone.) In my view, programs which help farmers gain access to improved technologies need to be expanded, but the importance of strategies which reduce input-dependence and promote greater self-reliance should not be overlooked.

But isn't SRI more labor intensive?

The question of SRI being more labor intensive has been the primary criticism raised on the practical level and in some reports has been cited as the main reason for farmers abandoning SRI once they have tried it. For farmers who are just learning the approach, careful transplanting of young seedlings will often require more time and energy, and this can be problematic when it coincides with the labor bottleneck that often accompanies the planting season. However in most cases the additional labor can be drastically reduced with a bit of practice, sometimes to the point where SRI can even save labor on transplanting because of the reduced planting density.

Weeds pose a bigger labor problem. Due to the drier soil conditions, wider spacing and younger plants, farmers generally have to weed SRI fields three to four times per season, whereas conventional flooded rice requires only one or two weedings. To address this issue in different settings, a number of labor-saving technologies have been integrated into the SRI approach. These include powered or hand-drawn weeders (for examples of different designs you can visit: <wassan.org/sri/documents/Weeders_Manual_Book.pdf>), judicious use of herbicides and even the selection of cultivars which grow vigorously enough to compete with weeds. Ultimately, while labor constraints may make SRI impractical in some areas, there are many other regions where this is not the case.

If you are interested in pursuing more compatible rice varieties (e.g. varieties that compete better with weeds, produce lots of tillers or tolerate periods of drought), I recommend that you start by contacting the agricultural extension departments in the country in which you work. Most Asian and many African countries have rice breeding programs with well-informed individuals that development workers can seek out and talk to directly.

The International Rice Research Institute (IRRI) can also be contacted for very small

Table 1. Comparison of Conventional and SRI practices.

Management Practice	Conventional	SRI
Land preparation	Bunded fields are puddled and leveled just prior to transplanting	Bunded fields are puddled and leveled just prior to transplanting
Seed requirement	50-80 kg/ha	5 kg/ha
Seedling age when transplanted	15 - 30 days	8 – 12 days
Seedlings per hill	3 - 4	1
Spacing	Ranges from 10 x 20 cm to 30 x 30	25 x 25 cm or greater
Establishment	Transplant seedlings in square pattern or direct seed pre-soaked seed in rows at a rate of 80 kg/ha	Using a square pattern, carefully transplant a single young seedling so as not to damage the root system.
Water management	Maintain 5-10 cm of standing water in field from transplanting to maturity. In direct seeded fields soils are kept moist but unflooded for 2 weeks after seeding. Intermittent irrigation is sometimes recommended in water scarce areas.	Irrigate intermittently every 5-8 days in order to maintain moist but not saturated conditions (commonly known as alternate wetting and drying or AWD).
Nutrient management	Mineral fertilizers applied at rates recommended by Leaf Color Chart* and/or Site Specific Nutrient Management* (SSNM) protocols. Addition of organic matter is recommended if available.	Preference for organic inputs such as compost, manure, leaves, straw, or ash. Add mineral fertilizers on a supplemental basis.
Weed control	Manual or mechanical control 1-2 times prior to canopy closure, or apply herbicides. Continuous flooding also controls weeds.	Mechanical control using a rotary weeder 3-4 times prior to canopy closure.

*For information on the use of Leaf Color Charts or Site Specific Nutrient Management visit www.knowledgebank.irri.org amounts of seed that are provided free of charge for research and development purposes. Recipients of seed from IRRI must be willing to submit legal documents such as a Material Transfer Agreement, but this process is not too difficult so do not let it intimidate you. Website: <http://www.irri.org/GRC/requests/Distribution_policy.htm>.

Another source of information is the Africa Rice Center, also known as WARDA <www.warda.org>. They might have NERICA (New Rice for Africa) lines, which have been geared specifically for the constraints faced in Africa.

Is SRI better for the environment?

This question is actually quite complex. Given the information available, it is probably impossible to say whether SRI or the conventional approach is more sustainable in the long term. That said there are a few benefits to SRI that in light of current environmental concerns will grow increasingly more relevant. At present, flooded rice accounts for almost 50% of all fresh water used in Asia; thus it is accurate to say that flooded rice both contributes to and is affected by water scarcity. Consequently there is a vital need for alternative technologies which reduce water use and enhance grain production per unit of water used. Alternate wetting and drying, which can be practiced alone or as a component of SRI, is an excellent way to save water over the course of a season. Other water saving practices include: direct seeding or gowing rice on raised beds. Since this environmental problem is only likely to grow, so too will the scope for SRI and other water saving technologies.

The anaerobic soils in flooded rice fields are a major source of methane gas, which has 20-30 times more global warming potential than carbon dioxide. Since SRI prescribes intermittent irrigation which keeps the soil moist but not flooded, methane emissions are greatly reduced. The potential savings in methane are partially offset by an increase in nitrous oxide (an even more potent greenhouse gas) but early research indicates that with better timing and more judicious use of N fertilizers there could be a net benefit of intermittent irrigation on total emissions. Whether or not these environmental benefits can actually be achieved by farmers who use SRI has not been adequately explored, but the potential is certainly encouraging.

Matching practices to environments

As we have gained more experience with SRI, we have learned that there are environmental and economic scenarios where certain components of SRI are a great fit and others where they can cause major problems (Table 2). We already discussed the labor issues which are tied to the transplanting and weeding operations. Another example is the trade-off associated with intermittent irrigation. When managed properly intermittent irrigation can certainly save water. But it is also an ideal strategy to cope with soils that have excessively high levels of iron, arsenic or sulfides, since these toxins are more available to the plant under flooded conditions. Unfortunately, intermittent irrigation can just as easily exacerbate problems associated with saline soils or parasitic nematodes. Furthermore the cycles of wetting and drying can increase the rate of organic matter oxidation and aerobic decomposition. In the case of organic muck soils this can often lead to rapid soil degradation and loss. Even in mineral soils the same processes may also lead to a decline in organic matter levels if sufficient organic amendments are not applied. Soil is like anything else in life, you can't get out what you don't put in.

As you can see, sorting out the pros and cons of SRI versus conventional rice production is no easy task. Thus far both systems have shown that they can help farmers boost production, yet both face very real challenges when it comes to technology transfer and implementation. Given these challenges, perhaps the best way we can assist rice farmers is to cast aside strict adherence to one system or the other and attempt to match individual practices to the environments in which they are best suited. Fortunately farmers tend to adapt technologies to suit their own needs anyway. Our job then is to provide them with a larger basket of options and perhaps a bit of guidance regarding when and where they should be used.

Table 2. Matching practices to different natural and economic environments.

SRI Practice	Ideal Situations	Non-ideal Situations
Alternate wetting and drying	-water scarce areas -soils prone to iron toxicity -acid sulfate soils which cause sulfide toxicity when flooded -soils high in arsenic, which can have adverse agronomic and food chain effects	-saline soils -soils affected by root knot nematode -flood prone areas -areas with poor water control -organic muck soils with high potential for oxidative loss of organic matter and subsidence
Lower seedling density	-reduced seed requirement helps cut costs on expensive hybrid seed	-low tillering varieties are unable to compensate for the wider spacing
Compost and crop residues	-areas where mineral fertilizers are cost prohibitive or where manure, crop residues, and biomass are abundant	-more difficult to implement in cultural situations where manure and crop residues are intensively used for fuel and feed
Intensive weeding	-additional aeration caused by soil mixing may help reduce risk of iron or sulfide toxicity on certain soils	-impractical in areas with labor shortages

References

Dobermann, A., 2003. A critical assessment of the system of rice intensification (SRI). *Agric. Syst.* 79:261-281.

Kabir, H., and Uphoff, N. (2007) Results of disseminating the system of rice intensification with farmer field school methods in northern Myanmar. *Expl. Agric*. 43:463–476. Cambridge University Press

Sinha, S.K., and Talati, J. (2007). Productivity impacts of the system of rice intensification (SRI): A case study in West Bengal, India. *Ind. Agric. Water Manag.* pp. 55-60.

Stoop, W.A., Uphoff, N., and Kassam A. (2002). A review of agricultural research issues raised by the system of rice intensification (SRI) from Madagascar: opportunities for improving farming systems for resource-poor farmers. *Agric. Syst.* 71:249–274.

Malted Barley Flour for Malnourished Infants

By Martin Price and Tim Motis

This article is in part based on a booklet called 'PowerFlour' by John L. Herlache, MD, and on information posted online by the PowerFlour Action Network <www.powerflour.org>.

Porridges are made by boiling traditional starchy foods such as cornmeal, rice, oatmeal, potato, or ground sorghum in water. The water seems to disappear, but in reality the water molecules are inserting themselves into the complex starch structures, causing the food to swell. The result is a familiar thick and sticky product that is more tasty and easier to eat than the dried meal would have been. However, it can be difficult for infants to swallow. Enzymes in malted barley flour (germinated barley seeds that have been carefully dried and ground into a powder) can convert these boiled staple foods into a semi-liquid form that is easier to swallow for infants, for adults suffering from starvation, or for AIDS patients with throat infections.

Cooked porridges can also be made thinner by adding additional water, but water used for this purpose is often dirty and results in diarrhea. In addition, adding liquid means that the porridge has a lower "nutrient density," so more porridge must be consumed to get the same amount of nutrients. This could result in the stomach becoming full before enough food has been eaten to provide adequate nutrition.

More important than liquefaction, the malting process in effect pre-digests much of the porridge, making sugars, amino acids, calories and mineral nutrients immediately available.

The immature digestive system of younger infants cannot produce the enzymes needed to digest some major components of starchy foods, including the starch and protein components. This presents a serious problem if the mother dies or becomes ill, is too malnourished to give enough milk, or quickly becomes pregnant again. Porridge may be one of the few options available to an extremely poor family as a substitute for or supplement to breast milk. (Note that the carbohydrate in breast milk is glucose, not starch, so no digestive enzymes are needed. Proteins in breast milk must be broken down by digestive enzymes, but the necessary enzymes come with the milk.)

Adults suffering from starvation, including people with advanced AIDS, face a similar challenge to infants in that their digestive systems may have ceased to produce the necessary enzymes.

What is malted barley flour?

Malted barley flour is simply sprouted barley grain that has been dried and then ground into a powder. Sometimes it is just called "malt" for short. Barley seeds are soaked in water to start the process of germination. As the seeds germinate, enzymes are produced that make sugar, minerals, and amino acids available to the developing seedling. It generally takes two days of soaking for germination to occur. Soaking is continued for an additional four days, at which point the sprouted seedlings are heat dried at carefully controlled temperatures and then ground into a powder. The final product is an almost white powder that is considered safe by the United States Food and Drug Administration. It is also inexpensive. Based on the cost of production in the United States, only US 1.5 cents would supply enough malt flour to make four cups of porridge every day for a week.

The process described above preserves the enzymes in their active state and provides a way to pre-digest starchy foods. The enzymes are the secret behind malting flour. An enzyme is a protein that speeds up chemical reactions many times faster than they would occur without the enzyme.

How is malted barley flour used to treat porridge?

Porridge is made the traditional local way (usually by boiling in water). Add ¼ teaspoonful (1 ¼ ml) of powder to a serving bowl or 4 teaspoons to a gallon of porridge, **after** the temperature drops to about 70°C (158°F). As you stir the malt flour into the porridge, it will quickly become thinner. Since malt flour breaks down sugars, the result is also a sweeter-tasting liquid that can be fed from a cup.

If you add the malt to the hot porridge right after it is made, the enzymes will be denatured (their 3-dimentional structure will be altered and they will lose the ability to do what you wanted them to do.) The enzymes will not be denatured by heat if they are added after the porridge cools to a temperature of 70°C or less. There are actually a number of different enzymes that have slightly different methods of action. Each enzyme has an ideal temperature where it works the fastest. So as the porridge cools, the enzyme that worked best at the higher temperature begins to slow down but other enzymes in their turn become the most active. By the time the porridge is a comfortable temperature for eating, they have probably each done their special task.

It would be good to use a thermometer at first, but you do not need to be too precise. We find that if the temperature of the porridge is low enough that we can just barely hold the bowl comfortably in our hands, it is probably at about the right temperature. We've always succeeded and have yet to use a thermometer. Successful treatment is visually obvious.

Figure 2: The photos at the left show a bowl of oatmeal before (top) and after (bottom) adding PowerFlour.

Where can I find the right kind of malt?

There are two kinds of malt, each with unique uses. The kind with enzymatic activity is needed for malting porridges, brewing and some baking uses. To make this kind of malt, the drying and grinding are done with great care so as not to inactivate the enzymes. If enzymatic activity is not important, for example when the malt is used for its special flavor, then higher drying temperatures are used. The high temperatures actually contribute to the flavor of malt. The two general kinds of malt are distinguished as "diastatic" or "non-diastatic" barley malt (or simply "malt powder").

Malt with active enzymes (high diastatic power) could very well be available in the country where you work. Such malt is sometimes referred to as "PowerFlour."

You might first try grocery stores or health food stores (if the latter are found in your country). If you cannot find it there, check with bakeries or brewing companies, or companies that sell ingredients to bakers or brewers. The enzymes in malt are an essential ingredient in making beer, so any country that makes beer has to be producing or importing malt with active enzymes. However, Dr. Herlache says you would need to do an extra step. "If [you] use brewer's malt, it will have to be ground or milled. The brewers like to have husk particles to help keep the brew flowing. For consumption, this is a problem."

The PowerFlour Action Network <www.powerflour.org> supplies trial amounts of Power Flour, the malt with the highest level of enzymatic activity. Brewing-quality malt will do the same thing; it will just require that you use a bit more malt.

Be careful, though. You may be more likely to find non-diastatic malt in stores that sell to the general public, because it is a common flavoring ingredient in food products. In the United States these would include some breakfast cereals and English muffins. That kind of malt would add flavor to the porridge, but nothing else. You may also find a preparation of non-diastatic malt that has been mixed with milk and wheat flour and dried, called "malted milk powder." This is commonly used in malted milk shakes and candy (e.g. malted milk balls or Milky Way candy bars). This, too, has no enzymatic activity.

You could try making your own malting enzyme, though this would be a last resort with commercial products being so inexpensive and superior. Tom Hartzell with PowerFlour Action Network (PFAN) shared the following: "Dr. Noel Vietmeyer [whose books on underutilized tropical plants first inspired ECHO's seedbank ministry in 1981] told me that several African cultures prepare their own "home grown malt" by sprouting millet, sorghum or barley (Ethiopians grow barley) to make an enzyme preparation for supplementing cassava flour or the like for children who have been weaned. It is very crude and often the mixture is moldy (could they be mycotoxins [i.e. like aflatoxin]?) or fermented." So it is worth the effort to try to find commercial malt.

Tom added, "If you cannot obtain a suitable malt in-country, you might consider importing PowerFlour. [If] you can cover shipping costs and have an on-going ministry, PFAN might be able to provide free product."

How does it work?

Three enzymes present in PowerFlour are especially important: amylases, proteases, and phytases.

Amylases break down large carbohydrates into more simple sugars that can easily be utilized by the digestive systems of infants and severely malnourished adults. Malt flours are assigned a "diastatic power" (DP), which refers to the amount of amylase enzymes present in the flour. Brewer's malt, for instance, has a diastatic power of 100-140 DP. High diastatic malt, such as PowerFlour, has a DP of over 200, so less of the malt is needed to convert the carbohydrates in a given time than would be needed with a malt of lower diastatic power. It is worth noting that enzymes are not used up in the process. They are called "catalysts" because the same enzyme molecule can split hundreds of carbohydrate molecules into sugars until something happens to damage (denature) the enzyme. So a comparable amount of a less powerful malt might achieve the same objective; it would just take more time or you would need to use a bit more malt.

Proteases are the second kind of enzyme. They cut proteins into smaller pieces that the body can readily use. Barley malt flour contains four kinds of protease enzymes.

Phytase is the third kind of enzyme. Phosphorus, potassium, iron, copper, zinc, magnesium, and manganese are stored in cereal grains in a complex substance called phytin. The enzyme phytase breaks down the phytin, releasing these essential nutrients and allowing them to be absorbed by the human digestive system. Neither children nor adults can make their own phytase, so the nutrients would just be excreted otherwise.

Where can I learn more?

The PowerFlour Action Network has helpful technical information on its website (www.powerflour.org), including a scientific study of benefits of Power Flour with malnourished children in Panama. You may write them at PowerFlour International, 600 Moasis Drive, Little Chute, WI, 54140; email: jwiley@elipticon.com.

John Herlache, MD, has written an exceptionally clear yet detailed 23-page booklet for the PowerFlour Action Network called *Power Flour*. It can be downloaded from the web at no cost at (http://powerflour.org/PowerFlourBook.pdf).

Acknowledgements

We would like to acknowledge John Herlache, MD, and Tom Hartzell with the PowerFlour Action Network, for helpful conversations and comments on this article. We also thank them for copies of the booklet and samples of malt that we have shared with overseas workers who were studying at ECHO.

ECHOES FROM OUR NETWORK

Drying Rice for Use as a Desiccant

Jennifer Gerson, working in Liberia, wrote to us about seed storage. While Jen was studying at ECHO she had read an article about seed storage in *EDN* 86, and also received instruction in using rice as a desiccant to lower the humidity in seed storage containers. She wrote, "...The humidity has been above 80% the entire time I've been here and it's rained every day, sometimes heavily...I brought over a handful of zip-loc freezer bags to store seeds. So I cooked some rice in a frying pan over the fire just for about five minutes. Some even got darker than I wanted but I thought I'd see if it would work anyway. And [the relative humidity inside the bag has] dropped down to 18% and stayed there. So you can tell Tim and Bob they don't have to bake the rice for an hour...5 minutes on the stove seems to do the same thing." [An advantage is that using a pan on the stove would use far less propane or wood than drying the rice in the oven.]

BOOKS, WEBSITES AND OTHER RESOURCES

Free Animal Health Publication from CVM

Dr. D. E. Goodman, editor of the quarterly *International Animal Health News* (IAHN, a publication of Christian Veterinary Missions) wrote to let us know that the IAHN journal is on the internet, and that subscriptions are free. Back issues are also available online. The journal can be accessed from the website <www.cvmusa.org>.

Dr. Goodman also commented, "For your readers not aware of our many other educational materials including comprehensive and inexpensive books on all of the farm animal species on animal health and production; as funds allow, some overseas organizations may qualify for free books." Contact Diana Baker at <dbaker@cvmusa.org> to inquire about eligibility. Be sure to mention what specific topics you are interested in and tell her a little about your work with small farmers.

Tropical Horticulture Course Information Available Online

Danny Blank, ECHO's farm manager, shared information about free course information that is available online. He commented, "This is a great resource for anyone wanting to look at all the class notes, PowerPoints and video lectures of Dr. Jules Janick for his class on Tropical Horticulture. It is a great resource for interns and others wanting an introduction to tropical soils, crops, climates, etc.!" The website address is <www.hort.purdue.edu/newcrop/tropical/>.

FROM ECHO'S SEED BANK

Jicama

By Wayne Niles

If you haven't grown or eaten jicama, *you should try it!* It is easy to grow in the tropics and is an exotic snack or a delightfully moist, crunchy, sweet addition to salads. We grew jicama (pronounced '*hee*-kah-mah") for years in northern Haiti and now find it just as happy in the soil and climate of our back yard in Kinshasa, Democratic Republic of Congo. It's not fussy; you just plant the seed and a few months later dig up the tubers. Our Congo soils are infested with nematodes, and our tomatoes struggle under an onslaught of spider mites. Jicama, though, grows as if there are no bugs around. That makes sense, as the vine contains its own built-in insecticide in the form of rotenone.

So what is jicama (*Pachyrhizus erosus*)? Native to Central America, it is also known as the Mexican Turnip or Yam Bean. The edible part is a large tuber that develops just below the surface of the ground (Figure 3). The rest of the plant is mildly toxic. Written descriptions of the tuber never adequately prepare you for the first bite. It is like an enormous, sweet radish, except crunchier and not at all hot, or like a carrot but with white flesh like a potato. Its texture is like water chestnut.

Jicama won't displace potatoes or cassava in your diet but will make a special addition to salads or an exotic vegetable for a meal. Jicama is mostly eaten fresh but can be pickled or cooked. It can be used as a substitute for water chestnut in stir fries because it retains most of its crunchy texture even with mild cooking. Served fresh, it is sliced, diced, or cut in sticks. It does not discolor after slicing. Harvested early, fresh jicama is about 90% water. It is high in Vitamin C and fiber. If allowed to mature in the ground, the tubers become higher in starch.

Figure 3: Jicama tubers.

Jicama is normally grown from seed and develops into a climbing vine (Figure 4). We usually trellis the vines to make room for other plants in the garden. At ECHO the vines are allowed to run as a ground cover. Jicama needs hot weather but not much water. The plant requires short days to form tubers. Hence, farmers in the tropics do not need to worry about competition from temperate regions. [Editors: At ECHO, jicama that is planted during the longest days of the year, May through July, begins to form tubers only when the days become very short. They are typically harvested in January. If planted later the plants only grow to about 2 feet tall.

We harvest the tubers for home consumption when they are 8 to 10 cm (3 to 4 inches) in diameter. At that stage they have a nice round, onion shape and are easy to peel and slice. They can grow up to a foot in diameter and weigh over 22 kg (50 pounds), but these large tubers are less appealing because they tend to be odd shaped and starchy. The tubers store well at room temperature in the tropics for several weeks. They store for several months when refrigerated.

The only problem we had growing jicama in Haiti was loss of the seed. Seeds didn't store well at room temperature. If you grow and like jicama, keep growing it regularly to keep a stock of fresh seed on hand. The seed are easily harvested from dry pods. Jicama is not weedy, but an abundance of seed can be produced in a few months if you have the discipline to not dig up the vines for the tubers.

Figure 4: Jicama vines growing on ECHO's farm. Flowers, leaves and pods are all visible.

The seeds are inedible because they contain rotenone.

In places where it is not yet widely grown (such as Kinshasa), jicama has the potential to be a major source of income to specialty vegetable growers. Try growing jicama—you're sure to succeed in the hot, humid tropics and you'll no doubt fall in love with it as we have.

ECHO can provide trial size packets of jicama seed upon request to development workers and overseas scientists ($3.00 to all others). Sorry, we cannot offer larger quantities. Jicama seed can often be found in local markets in Southeast Asian and Latin American countries. Ask around in places where you see the tubers sold.

UPCOMING EVENTS

2nd World Congress of Agroforestry

Nairobi, Kenya
August 23 to 28, 2009

The overall Congress theme is "Agroforestry—The Future of Global Land Use." The Congress is principally being organized by the World Agroforestry Centre (formerly known as ICRAF), based in Nairobi, Kenya. In addition to scientists and forestry professionals, the Congress is geared toward farmers and landowners, extension officials, and non-governmental organizations. Register online at <www.worldagroforestry.org/wca2009/>, or request a registration form from: The Secretariat; 2nd World Congress of Agroforestry; World Agroforestry Centre; United Nation Avenue, Gigiri, P.O Box 30677-00100; Nairobi, Kenya. Email: <WCA2009@cgiar.org. The deadline for submitting abstracts is already past. The registration fee is $400 before March 1, and $450 after that date.

16th Annual ECHO Agriculture Conference (EAC)

Fort Myers, Florida
December 8 to 10, 2009

Mark your calendars with these dates for the 2009 EAC. Additional details are not yet in place, but we want to give you plenty of time to plan for next December's conference. It will be the second year that our conference is held in early December rather than November.