EDN ECHO Development Notes

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and Dawn Berkelaar

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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Options for Water Treatment in Emergency Situations

This has been a year of natural disasters. One of the first emergency needs that we hear about is for clean drinking water. In many cases there is plenty of water if it could just be clarified and disinfected.

In this issue of *EDN*, we feature two articles about simple ways to treat water in case of emergency. The first involves using powdered moringa seed to clarify turbid water. The second describes the unbelievably simple technique of solar disinfection (SODIS) to destroy harmful microorganisms in **clear** water. Each method has been thoroughly studied in laboratory situations by itself and the results published in scientific journals.

It seems reasonable to us to propose that these two techniques, used together, should enable people in emergency situations to make even turbid (murky, muddy) water clean and drinkable, using only a few seeds from the moringa tree and some clear plastic bottles.

As far as we know, no one has done scientific tests to validate the effectiveness of the two methods when used sequentially. Ideally we would like to see turbid water that is known to contain common water-borne disease organisms be treated with moringa followed by SODIS and then tested. As you will read, that has been done with clear water with the SODIS technique. Even moringa treatment alone has been shown to remove a high percentage of microorganisms.

You might want to get some experience with these techniques so that if a disaster hits where you work, you will be ready to confidently give people a way to purify their own water. The techniques can also be helpful in everyday situations where cooking fuel for boiling water is scarce. Hopefully someone with scientific training will test the effectiveness of the techniques under various everyday situations encountered in areas that are impoverished or disrupted by a natural disaster. Let us know results if you try either or both techniques, and especially if you do laboratory tests.

Moringa for Emergency Water Treatment

By Beth Doerr, ECHO Staff

Seeds of *Moringa oleifera* can be used to treat water in an emergency or disaster situation. Studies since the early 1970's have found the seeds to be highly effective in removing suspended particles from water with medium to high levels of turbidity (moringa seeds are less effective at treating water with a low level of turbidity).

Moringa oleifera seeds treat water on two levels. First, moringa works as a coagulant. It contains positively charged, water-soluble proteins, which bind with negatively charged particles (silt, clay, bacteria, some toxins, etc). The resulting clumps or "flocs" settle to the bottom (flocculate) or are removed by filtration. Second, moringa also seems to work as an antimicrobial agent, though this aspect continues to be researched. Certain proteins in the seed seem to act as growth inhibitors on microorganisms. Treatments with moringa solutions have been found to remove 90-99.9% of the impurities in water.

In general, one moringa seed kernel will treat one liter of water (see Table 1 for dosage rates). Powdered seed kernels may be used for water treatment, but so can the solid residue (presscake) left over after oil extraction. Moringa seeds, seed kernels or dried

presscake can be stored for long periods, but moringa solutions for treating water (see step 6, below) should be prepared fresh each time.

Table 1: Dosage rates for using moringa seed powder to clarify water. NTU is a unit for measuring the turbidity (relative clarity) of water (see Figure 1).

Water Turbidity		Dosage Rate
Low turbidity	NTU<50	1 seed per 4 liters water
Medium turbidity	NTU 50-150	1 seed per 2 liters water
High turbidity	NTU 150-250	1 seed per 1 liter water
Extreme turbidity	NTU >250	2 seeds per 1 liter water

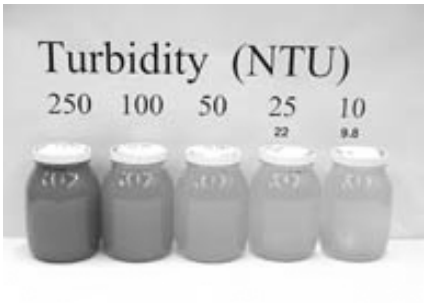

Figure 1: Examples of a range of turbidities, in units of NTU. Figure from North Carolina State University Water Quality Group, http://www.water.ncsu.edu/watershedss/info/turbid.html

Steps for Household Water Treatment

1. Collect mature *Moringa oleifera* seedpods and remove seeds from pods.
2. Shell seeds (remove seed coat) to obtain clean seed kernels; discard discolored seeds.
3. Determine quantity of kernels needed based on amount and turbidity of water (see Table 1 and Figure 1).
4. Crush appropriate number of seed kernels (using grinder or mortar and pestle) to obtain a fine powder and sift the powder through a screen or small mesh.
5. Mix seed powder with a small amount of clean water to form a paste.
6. Mix the paste and one cup of clean water into a bottle and shake for one minute to activate the coagulant properties and form a solution.
7. Filter this solution through a muslin cloth or fine mesh screen (to remove insoluble materials) and into the water to be treated.
8. Stir treated water rapidly for at least one minute then slowly (15-20 rotations per minute) for 5-10 minutes.
9. Let the treated water sit without disturbing for at least 1-2 hours.
10. When the particles and contaminants have settled to the bottom, the clean water can be carefully poured off.
11. This clean water can then be filtered or disinfected to make it completely safe for drinking. See the corresponding article in this issue on SODIS, solar disinfection of water. Alternatively, water can be chlorinated (1-2 drops of chlorine bleach per liter) or boiled (for a minimum of 5 minutes).

A few dangers must be taken into account. First, the process of shaking and stirring must be followed closely to activate the coagulant properties; if the flocculation process takes too long, there is a risk of secondary bacteria growth during flocculation. Second, the process of settling is important. The sediment at the bottom contains the impurities, so take care to use only the clear water off the top and do not allow the sediment to re-contaminate the cleared water. Third, moringa treatment does not remove 100% of water pathogens. It is acceptable for drinking only where people are currently drinking untreated, contaminated water.

Figure 2: On the left is a bottle containing turbid water. On the right is a bottle containing water from the same source that has been clarified using moringa seeds.

We conclude with a few final comments. Seeds of *Moringa stenopetala* have been found to be more effective than *Moringa oleifera* for purifying water (*M. stenopetala*, an African species of moringa, is also more drought-tolerant than the more common *Moringa oleifera* from India. Contact ECHO for a trial packet of seed for either species). Some studies have found that the levels of the active components in moringa seeds were lower in the rainy season, suggesting that seeds for water purification should be collected during the dry season. For water with medium turbidity levels, two trees could supply sufficient seeds for water treatment for a family of five.

Solar Disinfection of Water (SODIS): A case study from Kenya

By Larry Yarger

In 1996, issue #53 of *EDN* carried a short article that described how to disinfect water by using ultraviolet (UV) rays from the sun to destroy harmful microorganisms. It was very simple: clear plastic bags filled with water were allowed to sit in the sun. In order for this technique to work, the water must be clear (not murky).

The April 2004 edition of *Water Lines*, vol. 22 no. 4, summarizes a case study conducted in rural Kenya, in which this technology, now known as SODIS, is found to be an excellent method of disinfecting water for the rural homestead.

The basic treatment consists of filling several clean, transparent plastic ('PET' or 'PETE' (1) – polyethylene terephthalate) water or soft drink bottles with water and exposing them to full sunlight for at least six hours. The process is more effective if the water is aerated by shaking, and the bottles are placed on corrugated metal sheeting (roofing material) or on the house roof and exposed to the sun's rays. Smooth bottles that hold two liters or less are best. The type of plastic bottle is very important—make sure it is 'PET' or 'PETE'!

The following steps are recommended for SODIS:

1) Wash the bottle well before filling it.
2) Fill the bottle ¾ full with water.
3) Shake the bottle 20 seconds to oxygenate it.
4) Fill the bottle fully and cap it.
5) Place the bottle in the direct sun for 6 hours.
6) The water is now ready for drinking.

Exposure time should include the hours from 9:00 a.m. to 3:00 p.m. If skies are clear to partly cloudy, 6 hours is recommended. If the sky is covered more than 50% with clouds, treatment for two consecutive days is recommended.

A household health survey found that Kenyan households using SODIS had a 3-fold reduction in water-borne disease incidences compared to households not using SODIS. In the experimental part of the work, researchers measured the amount of fecal coliform bacteria as an "indicator organism" of pathogenic contamination. Water treated with SODIS had a 99.9% reduction of fecal coliform bacteria. SODIS effectively kills the following disease-causing organisms: *Escherichia coli, Vibrio cholerae, Enterococcus faecalis, Salmonella paratyphii, Salmonella typhii* (cause of typhoid fever and food poisoning), bacteriophage F2, rotavirus and encephalomyocarditis virus, *Candida, Geotrichum, Penicillium*, and *Aspergillus flavus* and *Aspergillus niger* (two species of fungi that produce aflatoxin). SODIS is also effective against protozoa organisms, some of which can cause disease. See Table 2.

In the community, SODIS project users compared SODIS with other methods of water treatment and rated SODIS number one over boiling, chlorination and filtration techniques, taking into account costs, ease of use, effect on the environment and efficiency in disease control. The community found that the technique is easy to use, costs little, saves fuel wood, saves time, and improves health.

The article recommends SODIS be further promoted as an acceptable method of disinfecting water for household use, thereby reducing the risk of waterborne diseases.

Tests conducted by the Swiss Federal Institute for Environmental Science and Technology (EAWAG) showed that while pathogenic microorganisms were killed, some microorganisms not harmful to human health were present in SODIS water. See SODIS website and technical notes for further details.

Table 2: Effect of SODIS technique on prevalence of various pathogens. Information from FAQ section of SODIS website (www.sodis.ch).

Pathogen	**Illness**	**Reduction via SODIS** H_2O Temp: 40ºC Solar Exposure: 6 Hours
Bacteria		
Escherichia coli	Enteritis [*E.coli* is also a water quality indicator]	99.9 to 99.99%
Vibrio cholerae	Cholera	99.9 to 99.99%
Salmonella spp.	Food Poisoning, Typhoid	99.9 to 99.99%
Shigella spp.	Dysentery	99.9 to 99.99%
Viruses		
Rotavirus	Diarrhea, Dysentery	99.9 to 99.99%
Polio Virus	Polio	* Inactivated
Hepatitis Virus	Hepatitis	Reduced In Cases of SODIS Users
Protozoa		
Giardia spp.	Giardiasis	99.9 to 99.99% (Infectivity of Cysts)
Cryptosporidium spp.	Cryptosporidiosis	99 to 99.9% (Infectivity of Cysts)
Entameba histolytica	Amebic Dysentery	* Inactivated

** Results not yet published*

For further information or to read the entire article, contact ECHO or the author, Stephen Burgess, Water Engineer, Christian Community Services (e-mail: burgess3404@yahoo.co.uk, elreco@africaonline.co.ke or sandcburgess@multitechweb.com). You can also refer to the SODIS website: www.sodis.ch

Exceptional Impact of a Novel Approach to Reforestation in Sub-Saharan Africa—an Update.

By Tony Rinaudo, World Vision Australia

Editor: In the October 1997 issue of EDN (#58) we featured a report of an innovative approach to reforestation in sub-Saharan regions that we nicknamed "the underground forest." The report was written by Tony Rinaudo, an Australian missionary to Niger with SIM. Recent visits to the region show that the technique has now had an incredible impact on a wide area of Niger, spreading primarily farmer to farmer. We asked Tony to share some of the exciting things that are happening.

Tony and World Vision Australia (his current employer) have put together a very helpful CD, well-illustrated with photographs, with every detail one would need in order to understand and implement this technique in other areas of Africa or other parts of the world where similar conditions exist. The formal name of the approach is "Farmer Managed Natural Regeneration." ECHO is proud to distribute the CD to our network. The cost is US$10. It is so important that we will cover the cost of airmail to get it to you. If payment is difficult for you, you may request a free copy (tell us something about your work). Naturally you need a computer to read the CD. Within a few months we will have the CD in French also. Below is Tony's update.

It has given me great pleasure to compile this manual and record of the history of Farmer Managed Natural Regeneration (FMNR) in Niger. FMNR is a form of tree coppicing and hence depends on the presence of living tree stumps that re-sprout after cutting. Desired tree stumps are selected. For each stump, a decision is made as to how many stems will be chosen for growth. The tallest and straightest stems are selected and side branches removed to roughly half the height of the stem. The remaining stems are then culled. Returning regularly to prune any unwanted new stems and side branches attains best results. Farmers choose the stumps they will manage, how many stems they will prune, when and how they will prune the stems, and when they will harvest the wood and what they will do with it. Because FMNR can become a grass roots movement, large areas of land can be 're-treed' rapidly for little or no cost, resulting in increased bio-diversity and benefits to people, the environment, soils, crops and livestock.

I had the privilege of returning to Niger in February of 2005 after a six-year absence, and I marveled at the extensive spread of trees across a country that, for all intents and purposes, was barren in 1980 when I first went there. I witnessed wood markets in areas that had been bleak moonscapes less than ten years previously. In 1980, because of misconceptions, trees were considered weeds in farmers' fields and they were vigorously and proudly slashed and burnt each year. An ill conceived Forestry Code made trees in farmers fields a legal liability, pitting forestry agents against land holders and herders. The code contributed much more to the demise of the trees it was meant to protect than the much-feared expansion of the Sahara desert itself.

The call to push back the encroaching desert had existed since at least colonial times. It gained momentum after the devastating drought and famine of the early to mid 1970's. Seyni Kountche, Nigerian president at the time, exhorted the population to plant trees with poetic abandon in phrases like "A land without trees is like a people without hope" emblazoned on billboards. Many heeded the call. The World Bank and numerous NGOs spent millions of dollars planting trees. Yet, out of an estimated 60 million trees planted over a 12-year period, less than 50% survived.

Why has FMNR spread where other efforts have either failed, or at best, succeeded only within the confines of the project area? I think many had been looking for the solution in the wrong place. Projects were based on exotic super trees while the indigenous vegetation was dubbed "useless scrub." Trust was placed in fences and guards and in expenditure of large amounts of money. But FMNR represents a social and environmental breakthrough, rather than a technical one. The greatest barriers were (1) a collective mindset that considered trees as weeds that needed to be cleared and (2) inappropriate laws that put responsibility and ownership of trees in the hands of the government and not in the hands of the people. Additionally, FMNR takes into account the rich natural resources already present in the landscape and works with them instead of despising and destroying them. In the intervening years since 1984, perceptive NGOs recognized the potential of FMNR and have quietly spread the method across the Niger. From there it has been spreading from farmer to farmer.

In June 2004, Professor Chris Reij (Vrije University, Amsterdam) wrote, "Here [in Niger] substantial FMNR is found on both sides of the road. Ten years ago villages could be seen from a great distance as the land was mostly denuded, but now they are hidden behind the trees." He visited again in early 2005 and wrote "FMNR seems more widespread and therefore more spectacular than I thought in June. On the way back to Niamey (capital of Niger) we had made the following calculation on the back of an envelope about the scale of natural regeneration in Niger. Taking a 100 km wide strip for 800 km of the main East West highway, and assuming that 25% of this area is being managed with FMNR, then 2,000,000 hectares (to be verified) are currently supporting natural regeneration."

In commenting on Chris' report, Dr. Mike McCaughley of the USAID International Resources Group talks about how FMNR itself was pivotal in changing the forestry code through what he calls the "sweaty-tee-shirt" approach to policy reform: "FMNR engendered the establishment and enforcement of local rules, thus lending itself to stronger local governance. And, because it graphically broke old paradigms that gave the State eminent authority over forest management, it contributed to changes in the Forest Codes and the Forestry Service. This case supports a policy reform process that builds on experiences from the field initiated and kept up by field practitioners. As Chris noted, what was initiated on a pilot basis in the mid-eighties became a national law in 2004. However, he also noted that it had been a *de facto* law for much longer. As per Chris's observation, a key to the transformation was that people "perceived" that they had the right to manage trees on their fields. And, FMNR provided the tangible, fact-based evidence for Natural Resource Management champions to make the case that local management was much more effective than State-directed control and that the more effective role of the State was to be a partner."

As famine this year tightened its grip on a third of the population of Niger, I was deeply upset at the unnecessary

suffering. At the same time, I wondered what, if any, difference FMNR had made. Eric Toumieux, the World Vision Senegal National Director visited south central Niger in September 2005 and wrote this report:

"I just came back from Niger where I witnessed the successful efforts of a community of 36 villages to set in place sustainable mechanisms to overcome natural disasters. I was absolutely amazed by what I saw. In an environment very similar to that of Baba Garage, Senegal (350 mm of rain, widespread millet and peanut farming, threats of desertification with sand encroachment and dust winds), these 36 villages have set in place a mechanism to encourage natural regeneration of trees on their fields. The results are astounding: each farmer now leaves an average of 100 to 200 bush trees to regenerate on his field instead of chopping them down before the rainy season.

"Newly regenerated trees are protected by a committee composed of farmers (both men and women) and herders. Farmers have learned pruning and trimming techniques that allow trees to grow fast vertically, so as not to hinder the growth of millet under them. This year, when a deadly combination of locusts and drought struck the entire area, farmers in the villages overcame the tragedy by selling firewood as well as by-products from the trees. As a result, there is no need for any food distribution in this community, unlike what is happening elsewhere in Niger. Village authorities are even planning to set up a wood market in the area so that they can export their surplus to the capital city and to neighboring Nigeria with better prices! Can you imagine that happening in central Senegal?"

As recently as 1988, villagers in this region were so impoverished that they were 'mining' long dead tree stumps in order to sell them and buy food. One stump might require four days of backbreaking effort to remove. Today, so great is the economic return from FMNR that the elders of these villagers are planning to sell wood to the capital – a distance of 650 kilometers!

With the aid of the CD on Farmer Managed Natural Regeneration, the possibility for spreading this technique even further afield is greatly enhanced. USAID, World Vision and others have already introduced FMNR to other West and East African countries. The potential is simply enormous. My hope is that this simple, cheap and effective technique will spread throughout the world, wherever it is applicable.

Burning Neem Oil for Malaria Control

Summarized by Dawn Berkelaar

In an experiment reported in the *Indian Journal of Malariology* (33: 81-87), authors M.A. Ansari and R.K. Razdan describe how burning 1% neem oil in kerosene lamps from dusk to dawn resulted in the movement of the mosquito *Anopheles culicifacies* (a carrier of the malaria pathogen) from living rooms to cattlesheds. As a result, the incidence of malaria in experimental villages dropped significantly.

Lamps used were 100 ml capacity, with a wick and regulator. Rooms in the study were 3.5 m x 3.5 m x 3.5 m. In the experimental village, the average number of mosquitoes per room went from 64.8 to 14.06. In the control village, where plain kerosene was burned, the average density of mosquitoes dropped from 87.25 to 55.0. When lamps were taken away, the density of *A. culicifacies* increased again.

The authors pointed out that the degree of protection conferred by neem oil varies between different species of mosquitoes.

Before the experiment, the number of cases of malaria per 1000 people in the experimental village and the control village were similar (3.1 and 2.6, respectively). During the experiment, cases/1000 for the experimental village was 1.03, compared to 9.6 for the control village.

Plasmodium falciparum is the species of malaria that most often results in death. In villages where 1% neem oil was burned with the kerosene, no cases of *P. falciparum* malaria were reported. In control villages where plain kerosene was burned, data showed 4.3 cases of *P. falciparum* per 1000 people.

The neem oil used in the study was obtained from a pharmaceutical company. Oil produced locally would be cheaper; the authors estimate a cost of Rs. 35-50 per liter for locally produced oil. Neem oil for this use would cost Rs. 2.0 per person per year, while kerosene would cost Rs. 8.0 per room each month. The authors claim that the cost of this technique for malaria control would be cheaper than coils or impregnated mats. [DRB: We do not know what the effectiveness of this locally produced oil would be compared to oil obtained from a pharmaceutical company.]

Recent Workshop: "Resilient Crops For Water-Limited Environments"

By Martin Price

For science to benefit the very poor, the results must cost them nothing or nearly nothing. Developing (and not patenting) a greatly improved variety of an existing crop is one of the best ways to meet this criterion. As ECHO serves those of you working with small farmers around the world, we keep a keen eye open to see what the research centers are doing that may eventually impact your work. I will be traveling to some of the international research centers in the CGIAR network in 2006 to try to "mine" some of the agricultural gold that is found in their seedbanks and publications, and to establish relationships with more of their researchers.

I was pleased to read about an emphasis on developing a range of drought-tolerant crops. The following is abstracted from a May 2004 note on the CIMMYT website at http://www.cimmyt.org/english/webp/support/news/workshop_rockfllr.htm.

"Drought, arguably the greatest threat to food production worldwide, was the focal point of a high-level, weeklong workshop in Mexico last May supported by the Rockefeller Foundation and CIMMYT."

Approximately 140 scientists from Asia, Africa, and Latin America—working on various aspects of drought tolerance in plants—met to present their research results and discuss ways forward with their colleagues. The meeting looked mainly at maize, rice, and wheat, which account for more than half of the calories consumed by people in the developing world.

Dr. Gordon Conway, President of The Rockefeller Foundation, explained that 70% of the one billion Africans and Asians in extreme poverty (living on less than $1/day) live in rural areas, and that agriculture is their primary route to improved nutrition and income. "In the 1960s and 70s, the Green Revolution saved hundreds of millions from famine, but many living in less favored environments were bypassed as much of the success was based on adequate water and soil fertility. **What is needed now is a Doubly Green Revolution to lift up the African and Asian smallholders left behind.** Drought tolerant crops are key to this cause."

ECHOES FROM OUR NETWORK

Propagating Breadfruit

Angela Boss wrote to ECHO from Central African Republic. "I wanted to write and share with you a recent success we have had in propagating breadfruit. As you may already know, breadfruit is seedless and cannot be propagated by grafting or marcotting (air layering). The principal method of propagation that we know of is to take root cuttings and plant them in sacs or in the ground. Our nursery manager, Chrysler, and I tried an experiment this summer with our trees here in Gamboula. We dug a shallow trench (10-15 cm deep) about 1-2 meters out from the drip line around our breadfruit trees. This exposed roots that were about a pencil width in diameter and then we waited. Within a couple of months we had shoots coming up from the roots on the side of the trench farthest from the tree. Once they reached a decent size we dug them up and transplanted them. We came up with the idea ourselves although I am sure it has been tried before. I felt like I should share it with ECHO none-the-less."

BOOKS, WEBSITES & OTHER RESOURCES

Agroforestry around the World…Around the 'Net'

By Larry Yarger, ECHO Staff

If you were to look up 'Agroforestry' on the Internet, you would find in excess of 517,000 website listings for the term. To reduce the amount of time and effort it would take to check this list, the **World Agroforestry Centre** has compiled a list of **80 websites** that comprehensively covers the science and practice of agroforestry. Many of the sites will also lead to other sites in the same or associated fields.

Website address: http://www.worldagroforestry.org/SubContent.asp?ID=24&Category=What%20is%20Agroforestry?&SubCategory=Agroforestry%20on%20the%20Web

Headquarters: World Agroforestry Centre (ICRAF); United Nations Avenue, Gigiri ;PO Box 30677-00100 GPO; Nairobi, Kenya; Telephone: +254 20 524000 or via USA +1 650 833 6645; Fax: +254 20 524001 or via USA +1 650 833 6646; Email: ICRAF@cgiar.org; www: http://www.worldagroforestrycentre.org

FROM ECHO'S SEED BANK

Sauropus androgynus (Katuk): A Nutritious Perennial Green

By Tom Gill, ECHO Seed Bank Assistant Manager

Other common names: Sweet Leaf Bush, Star-Gooseberry, Chekkurmenis, Chekup Manis, Changkok Manis, Japanese Malungay)

Arguably, as we work toward food security the promotion of perennial crops should be at the forefront of our minds. Through their use, we can hope to achieve more constant, year-round production. One of our favorite perennial vegetables for hot, humid climates is *Sauropus androgynus,* often known as "katuk." Katuk offers high vigor, long life, and year-round production of nutritious greens.

S. androgynus has its origins in the hot, humid lowland rainforest of Borneo. It is more vigorous at lower altitudes but is grown in Malaysia and Indonesia at altitudes of up to 1300 m (4000 ft). Katuk can tolerate occasional flooding and will grow under very wet conditions, where annual rainfall reaches 3000 mm (120 inches). It also tolerates acidic soils. It will grow in full sun or partial shade. Ideal spacing between plants is 60-90 cm (2-3 ft). Because it is native to the rainforest, katuk is an ideal understory species in agroforestry systems.

S. androgynus has a variety of common names, mainly from southeast Asia, where it is grown as a staple vegetable. The tender shoots, flowers, and young and old leaves are all used for food. The leaves are sweet with a nutty flavor, and are reported to have medicinal value—

prepared as a vegetable, the leaves are recommended for women after childbirth to stimulate milk production and recovery of the womb (Ram, 1994). Katuk leaves also retain their color and firmness when cooked.

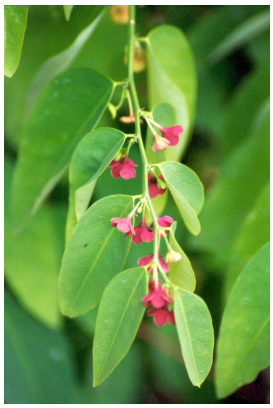

Figure 3: Katuk leaves and flowers. Photo by ECHO staff.

The nutritional value of katuk is exceptional (see Table 3). The leaves contain 6-10% protein by (fresh) weight. It has huge potential for areas of the tropics where vitamin A deficiency is a problem, especially among malnourished children. It has even been reported (Seibert, 1986) that katuk was the major source of food (along with shell fish!) for a few Japanese soldiers who were hiding in Philippine caves for 25 years after World War II!

The young shoots of katuk are tender and succulent, and are often prepared as a delicacy in East Asian cuisine. These prized shoots are produced rapidly by farmers in Malaysia, who force new growth of stem tips through appropriate pruning, fertilization, irrigation, and use of shade cloth. Dr. Martin Price, ECHO's Executive Director, comments on these stem tips: "The top 5 inches (13 cm) are harvested…and sold to the finest restaurants. I ordered them at the Hilton Hotel in Borneo then watched as they were stir fried for about one minute. The bottom inch was discarded to ensure only tender tips would be prepared…" (Meitzner & Price, 1996).

Pruning is essential for effective cultivation because, if left unchecked, the plant will grow so tall that it will fall over. Katuk should be pruned to between 1 and 2 meters (3-7 ft). Pruning encourages the constant production of new tender growth. [Ed (MLP): I grow katuk on the north side of our home, in about a three-foot (one meter) area along the wall and under the roof's two-foot overhang. This small area has produced a continual supply of greens (far more than my wife and I can consume) without insect or disease problems for 17 years. Each year it grows so tall it reaches the roof at about 10 feet and is then pruned. Production ceases during the three months each year with coolest temperatures and shortest days.]

S. androgynus may be eaten raw or cooked. However, when raw katuk extract became a popular ingredient of a weight control program in Taiwan in 1994/5, it resulted in several reported cases of poisoning. Those affected were consuming very high quantities of the raw katuk extract with fruit juice, and some developed a rapidly progressive obstructive lung disease, possibly linked with the alkaloid papaverine found in katuk (Ger *et al.,* 1997). It must be stressed, however, that there is no evidence that eating cooked katuk or raw katuk in moderate amounts is harmful in any way.

	Actual quantity per half cup serving of fresh leaves		% Daily Value USDA, 2000 calorie diet	
	Katuk	Spinach	Katuk	Spinach
Protein	4.9g	0.43g	9.8	0.9
Calcium	51mg	15mg	5.1	1.5
Iron	2.7mg	0.4mg	15	2.3
Vitamin A	1122 IU	1407 IU	22	27.6
Vitamin C	83mg	4.2mg	138	7

Table 3: Nutritional value of Sauropus androgynus versus Spinacia oleracea: Serving size ½ cup of fresh leaves (Oomen & Grubben, 1978, www.nal.usda.gov/fnic/foodcomp/search/)

Katuk flowers are small and red, and are characteristic of the family *Euphorbiaceae* (see Figure 3). The fruits are pink/yellowish-white round capsules that typically contain 4-6 seeds. The seeds are black when mature. The flowers may be cooked and eaten. One member of our network has even mentioned that he has eaten the fruits, but we are reluctant to recommend that without further information.

Katuk can be propagated by seeds and cuttings. However, the viability of both seeds and cuttings is short-lived, so both should be planted as soon as possible after collection. Seeds are viable for only 3-4 months when kept dry and cool. Even while seeds are still viable, germination will be probably 50% at best. Seeds should be removed just as the seedpod is beginning to crack open. Germination will be higher if the seed coats are pulled off just prior to planting. Seeds should germinate in 2-4 weeks, but they may take up to 5 months. We grow katuk as edible hedges around the ECHO farm. We have noticed that some seeds that have fallen around these hedges have sprouted on their own.

Propagating by cuttings is often preferred to planting seeds. Using an established plant, propagation by cuttings is very easy and highly successful. To propagate, cut a 20-30 cm (8-12 inch) section from a mature branch with 2-3 nodes. Remove all stems and leaves from the cutting, and make sure that the bottom end of the cutting is within 3 cm (1 inch) of a node. Plant the cutting at a depth of 10-15 cm (4-6 inches) with only 1 node exposed. A crop can be harvested just 4 months after planting.

Katuk has minimal pest and disease problems. Minor pests include the Chinese rose beetle (*Adoretus sinicus*) and slugs, which both can damage young plants.

Although katuk is moderately drought tolerant, it is not an appropriate choice for areas with an extended dry season of 7-8 months, unless there is access to irrigation and/or heavy mulching is practiced. Katuk will also not grow as vigorously in areas with poor or depleted soils, unless considerable quantities of

organic matter or other nutrients are applied.

Seeds and/or cuttings are available from ECHO's Seed Bank. Trial-sized packets of seed or cuttings are available free to those working overseas in agricultural development. All others may purchase the seeds or cuttings from ECHO. The overseas price for seeds is $3.50/packet and the domestic price is $3/packet. Cuttings are available for purchase at $5 per cutting, with a minimum order of five cuttings. To place an order, contact us at echo@echonet.org or go to www.echotech.org.

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UPCOMING EVENTS

College Credit at ECHO—"Tropical Agriculture and Missions" Course

By Martin Price

If you have ever visited ECHO, you know that we may now have the largest collection of useful plants for small-farm tropical agriculture in the USA. We also have numerous demonstrations of appropriate technologies and cropping systems. No college or university that we know of in North America has equivalent resources for teaching. For years we have recognized the potential for ECHO to be the site of an incredible course in tropical agriculture, using the farm as a "laboratory," our unique library for reference material and our experienced staff for teachers. As of three years ago, just such a course has been developed and is now offered each summer.

The three-week course is taught at ECHO under the direction of the Au Sable Institute of Environmental Studies (www.ausable.org). Au Sable offers a wide range of environmental courses for more than sixty Christian colleges in the USA and Canada. Courses are taught from a Christian perspective. Undergraduate credit in Au Sable courses is granted through a student's home institution. Graduate credit has also been arranged, and we hope to increase options for this. For those who do not need the course credit, a (lower) audit fee of $600 is available for the course.

The professor of record is Dr. David Unander, Chair of the Dept. of Biology at Eastern University in Philadelphia. He was a plant breeder with the University of Puerto Rico for several years and has been involved in missions, research and teaching in several Caribbean Basin countries.

You can see a sample syllabus, photos and an overview of past classes at http://www.eastern.edu/academic/trad_undg/sas/depts/biology/Trop%20Ag%20Missions%20Au%20Sab%20ECHO.htm. For information contact Dr. David Unander (phone: 610-341-5860; email dunander@eastern.edu) or Dr. David Mahan, Admissions/Registrar at Au Sable (phone: 231-587-8686; email mahan@ausable.org).

The 2006 course will be offered May 16 through June 3 at ECHO.

2nd International Conference on God and Creation

Brackenhurst Conference Center
Tigoni, Kenya
March 8-11, 2006

The first conference on God and Creation was held in Kenya in January, 2004. Church leaders in East Africa are realizing that "as Christians, we have an urgent and profound responsibility under God to care for creation." Topics at the conference include worldview and the environment; Biblical principles of environmental and agricultural stewardship; poverty, food security and the environmental crisis; environmental and agricultural stewardship in missions; and mobilizing the church to obedience in caring for creation.

The God and Creation conference is suggested for pastors, church leaders, seminary professors, missionaries, NGO staff, and others who are concerned about the environment and agriculture in Africa.

Pre-register before February 18 by submitting in writing your full name and mailing address, church or organization, e-mail address and phone number. Contact information: Craig Sorley or Francis Githaigah; Brackenhurst Environmental Programme; P.O. Box 32, Limuru, Kenya. Email: ctsorley@att.net (Craig); kyherbflora@yahoo.com (Francis); phone: (254) 66-73007/097/115/356; Fax: (254) 66-73279. www.careofcreation.org