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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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Indoor Air Pollution from Cooking Fire Smoke

By Dawn Berkelaar

The majority of people in developing countries cook over open fires. In many countries in sub-Saharan Africa, over 90% of the population cook their food with biomass (plant material). The smoke from such fires can be a nuisance, and it can also lead to severe health problems. The Intermediate Technology Development Group (ITDG) has issued a document called "Smoke—the Killer in the Kitchen" that shares statistics on indoor air pollution caused by burning solid fuels like wood, charcoal, and crop residues. The document also suggests steps that can be taken to minimize health risks. Unless otherwise indicated, the information below is summarized from the ITDG document (Warwick and Doig, 2003. Download from www.itdg.org).

Dangers from Wood Smoke

Smoke from burning biomass fuels inside the home is the fourth leading cause of death and disease in the world's poorest countries. The indoor air pollution that results from burning solid fuels kills more than 1.6 million people, mostly women and children, each year. This works out to more than three people per minute. It is a higher death toll than that caused by malaria!

The poor, especially poor women and children, are most affected by indoor air pollution. Of the 1.6 million people who die each year because of indoor air pollution, 56% are children under five years of age. Most of these children die from acute lower respiratory infections. Young children tend to spend most of their time with their mothers, meaning they are near the cooking fire a lot. The ITDG document states, "The impact this length of exposure has on small children is exacerbated by a number of factors. Children's airways are smaller, therefore more susceptible to inflammation. Their lungs are not fully developed until they are teenagers, so they breathe faster. Also, their immune systems are not fully developed—a process that may be further delayed by malnutrition."

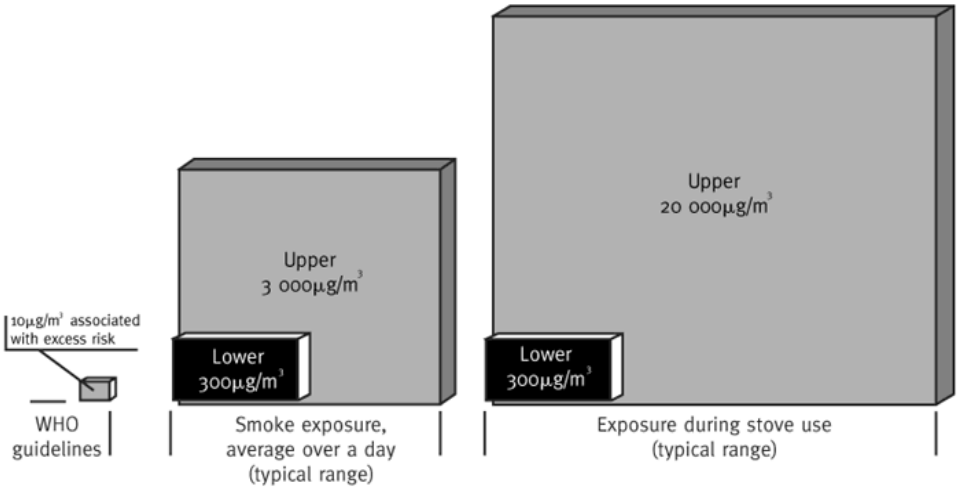
According to the ITDG document, the United Nations Development Programme claims that "the use of poorly ventilated, inefficient stoves 'can have the same adverse health impacts as smoking two packs of cigarettes a day.'" Throughout the developing world, poor people are exposed in their own homes to levels of pollutants that are 100 times higher than accepted safety levels! (see Figure 1, next page)

In December 1952, a smoke-laden fog called The Great Smog hung over London for six days. Deaths that resulted were estimated at 4,000. Deaths from bronchitis and pneumonia increased by seven times. Yet in developing countries, women and children are exposed to similar levels of particulate pollution for up to seven hours a day, every day.

The ITDG document includes a quote from a review by Professor Kirk Smith from the University of California: "Biomass fuel smoke contains significant quantities of several pollutants for which many countries have set outdoor air quality standards—for example, carbon monoxide, particles, hydrocarbons, and nitrogen oxides."

Indoor air pollution can cause illnesses including acute lower respiratory infection, such as pneumonia (35.7% of cases caused by exposure to smoke from solid fuels); diseases such as chronic bronchitis causing "progressive and incompletely reversible obstruction

Figure 1: Comparison of typical levels of particles less than 10 micrometers in size in developing country homes (represented by gray and black boxes in middle and on right) with WHO guidelines (small gray box on left). Figure used with permission from ITDG.



of the airflow"; lung cancer (in China and India, around two-thirds of women with lung cancer are non-smokers); tuberculosis; asthma; and cataracts. Recently there have been many health studies demonstrating a link between indoor air pollution and illness or death.

Even in countries whose economies are in transition, people are reverting back to the use of solid biomass fuels. With economic downturns, infrastructures sometimes collapse and people can lose access to the power grid and to cleaner fuels. In Tajikistan, where just such a thing has happened, there was a 35% increase in cases of acute respiratory infection between 1991 and 2000, largely because of burning wood indoors.

In addition to suffering from exposure to smoke, women carry the burden of having to find firewood or other fuel. Estimates for the time they spend collecting fuel range from two to twenty hours per week!

A few years ago we learned of a study by Dr. Wayne Bragg and Dr. Gene Shultz, Professor Emeritus at Washington University in St. Louis. We contacted Dr. Shultz to find out more information. Dr. Shultz and Dr. Bragg worked with local colleagues in northeast Brazil and central Mexico. They investigated indoor air pollution in rural households, caused mainly by burning wood and other household fuels in cook stoves. They measured the concentrations of very fine particulates (that are associated with certain respiratory and eye diseases) in smoky atmospheres typical of the homes of the rural poor.

Dr. Shultz told ECHO, "Instead of measuring smoke particulates at fixed locations in the home, we were interested in the particulate burden that a typical woman might breath [while conducting] a task such as preparation of a meal, using her own cooking equipment in her own kitchen, and cooking her own foods. Therefore, we asked each cook to wear a small belt-mounted battery-operated air pump that sucks room air at approximately the rate of breathing, through a flexible tube, with the opening located on her shoulder. The air was passed through a micro filter system to entrap fine particles from the room air—particles that are usually deeply respired into the lungs.

"The cook would wear this equipment during preparation of a typical meal, following her normal patterns of behavior. At times she would be hovering over a smoky stove. At other times she might be on the other side of the room cutting up food. She might even walk outside to throw something to the chickens. We did not interfere with her normal patterns of behavior. She wore the equipment just for the length of time required to complete the preparation of the meal.

"We were interested in measuring the weight of very fine particles that she is likely to collect in her lungs during meal preparation. The particles entrapped on the micro filters were weighed by special equipment available at a world-class air pollution lab at the University of Sao Paulo, Brazil.

"As part of our program of research, we worked with a team of indigenous researchers who carried out a survey of fuel usage patterns. Typically, they would interview the cook and other members of the household in their own language to better understand the types of wood that were preferred and why, the types of wood that the cooks actually used and why, etc. In addition, the interviewers asked questions to all the members of the household about the incidence of certain smoke-related illnesses in their homes (for example, respiratory illnesses and cataracts).

"In brief, we found a great diversity of results. Some women were able to minimize the smoke in their homes. Usually these were younger women who could walk the longer distances to gain access to less-smoky wood species. Older women often had to accept the more smoky species nearby that had been passed over by those who could walk farther.

"Most women were relatively unaware of the hazards of smoke. But, remarkably, some had figured it out on their own and had successfully enlisted their husbands with handy skills, in the tasks of cutting down on household air pollution by fixing the stove and chimney or by learning to use ventilation. These women with "exemplary" kitchens were definitely in the minority. We were discouraged to find that most men were unwilling to help their wives. It was [the wives'] problem, not the men's problem. Also, knowledge [about] the hazards of smoke and how to mitigate them did not diffuse easily from one family to another, even when the families were closely related and in daily touch. Of course, in many cases we were dealing with those who were so poor that they had to scramble

to survive. Their priorities did not include household smoke or chimney repair.

“In Brazil we found many examples of chimney flues that exited the kitchen horizontally, or nearly horizontally, and never turned up vertically outside the kitchen wall. Thus no draft was being generated, and so no smoke was being eliminated from the kitchen. There was widespread ignorance of this simple principle in several villages, even though a very few women understood this problem and managed to avoid it.

“Clearly, the problem is at least as much a social problem as a technical problem, and we are of the opinion that it is best studied and solved by interdisciplinary teams and methods.

“Although we aren't medics, we were aware of a high incidence of respiratory problems in children, women and elderly, even in the case of non-smokers. There was also a high incidence of cataracts in the elderly, men as well as women, since elderly men spend a lot of their time indoors. Kitchen smoke isn't confined to the kitchen. It migrates throughout the houses we saw. No one escapes it.”

Switching to a Cleaner Fuel

There are ways to reduce people’s exposure to such high levels of smoke. Switching to a cleaner fuel is a good option for the relatively few people who can afford it. Examples of such fuels include liquid petroleum gas, kerosene, or biogas.

Biogas is made from dung and other organic waste materials. It is very effective and results in a gaseous, clean fuel. In Asia, the introduction of biogas is proving very successful (with 120,000 bio-gasifiers in Nepal alone), but it is harder to introduce biogas in Africa for cultural reasons.

Removing Smoke from the House

Another good option for reducing exposure to high levels of smoke is to use well-designed chimney stoves or to use smoke hoods. These can reduce indoor air pollution by up to 80%.

Smoke hoods and improved ventilation, introduced by an ITDG project in Kenya, resulted in a nearly 80% reduction of particulate and carbon monoxide pollution in homes. Unlike chimneys, smoke hoods are freestanding and are not attached to the stove.

Enlarging eave spaces in a traditional house in Kenya resulted in a 60% reduction of respirable particulates. Enlarging windows did little to reduce air pollution, but windows are necessary in houses that have smoke hoods, so that air can flow through the house.

[Ed (MLP): I have read of unexpected side effects from removing the smoke too. Examples include loss of protection from insects that harm thatched roofing material or grains stored on the ceiling, or from insects that cause human illness. I wonder if this might be true of the insect in the Andes Mountains that causes Chagas disease. It drops from the ceiling at night onto the bed and bites a person. Years later the individual might experience heart disease as a result.]

Improved Stoves

Of the energy from a kilogram of wood that is burned in a three-stone wood-fired stove, about 18% of the energy goes into the pot, 8% into the smoke, and 74% into wasted heat. Not surprisingly, most work on stove design has been done to improve energy efficiency and to save fuel. However, these modifications are not necessarily effective at reducing indoor air pollution. In fact, according to the ITDG document, “Studies have shown a small decrease [in emissions] from certain improved stoves, although many stoves in fact increase emissions if air flow to the fuel is restricted.”

Stoves that incorporate a flue or chimney are often very effective at reducing the amount of smoke in a house. Two stoves with these features are the rocket stove and the Ecostove, both of which are being used in Central America (see below for more details about these). However, there are potential problems with chimney stoves. In order to work, they need to be properly designed and installed. Sometimes they are expensive. Soot can also make them ineffective without regular cleaning.

Reducing Need for Fire

One very simple technology that can reduce the amount of fuel necessary for cooking is the “hay box.” Food is heated to boiling, then it is placed in a box that has been filled with insulating material (e.g. dried grasses or crumpled newspaper). The food will continue to cook slowly. The concept is similar to that of a slow cooker. In Nairobi, the development organization Winrock found that hay boxes were proving as popular as improved stoves with women’s groups. For more information about hay boxes, visit the following website: www.lostvalley.org/haybox1.html.

In areas that are consistently sunny, solar water heaters can be used to provide warm water (around 60°C) and this can reduce the need for fire to heat water. Solar water heaters can be made very simply from black pipe and plastic [or metal] drums painted a dark color.

Solar cookers can also be used to reduce the need for a fire. They can be made very inexpensively (e.g. from cardboard and aluminum foil) and work by concentrating sunlight directly onto the food. They can be extremely effective, but according to the ITDG document, they have had limited success in practice. One reason for this is that, in many cultures, the main family meal is eaten in the evening, whereas solar cooking is best done in the middle of the day when the sun is highest [though combined with the hay box, this obstacle could be overcome]. Another reason for limited success is that in order to use a solar cooker the cook must work out of doors, which reduces privacy. As with many projects, solar cookers need to be developed with input from the intended users if they are to be accepted and used widely. Stan Doerr, a new ECHO staff member with years of experience in Africa, says he has seldom seen a situation where solar cooking became popular over a long term. One reason that he cited is the important social structure for

women that centers around preparing food. Still, information on this type of technology abounds. The web site www.solarcooking.org/docs.htm has a wealth of information, including several designs that range from extremely simple and inexpensive to very sophisticated.

Look for Species with Less-Smoky Wood

Dr. Schultz (whose work was described above) suggested growing and using trees with less-smoky wood. He wrote to ECHO, "Shrubs and fast-growing trees that create minimal smoke would be highly desirable, but little seems to be known about such species, especially about local shrub species. What is needed is something that is similar to oak (low smoke production), but grows rapidly. Local women know the best and the worst species, and where to find them. Species that do NOT contain the resinous materials that produce a lot of smoke still exist, farther from the villages. But these are accessible only by the younger women, and especially by women still able to walk long distances and who also have children old enough to walk with them and help them carry and collect fuel.

"Older women are definitely disadvantaged. Fast growing shrubs and trees that produce little smoke when properly dried might be planted close to their homes. Although this is a bit out of my field, I imagine that the better species could be identified by interviewing women to get the common names, and using botanists in local universities to match the common names with Latin names and to identify the best propagation methods.

"Ideally, this initiative to encourage the use of better wood fuels should be matched with local efforts to repair stoves, flues and chimneys, and to arrange kitchens such that prevailing winds can be used to clear most of the smoke from kitchens. One obvious step would be to place the stove under a window on the leeward side of the kitchen [i.e. on the side toward which the wind is blowing], so air movement from the windward side of the kitchen would push the smoke out the leeward window."

Changes in Behavior

Sometimes simple changes in behavior can reduce women's exposure to smoke. "For example, making sure that fuel wood is dry cuts emissions. The use of a pot lid can reduce the fuel consumed during simmering by a factor of three and overall emission levels by almost a half" (ITDG document). Keeping children away from the fire (if possible) will reduce their exposure to smoke.

Though not a concern in many areas of the tropics, in some places an open fire is used not only to cook meals but also to heat the home. Efficient stoves are typically well insulated, meaning that less heat will enter the room. Likewise, chimneys help remove smoke, but also conduct heat away from the home.

ITDG summarized, "Cooking is a deeply cultural and domestic task and communities themselves, particularly the women, must be directly involved in developing solutions that suit their circumstances….Experience has indicated that there is no point trying to dictate a solution to a community."

With that said, solutions have been found in different communities, and there is much to learn from them. Many, many stoves have been designed to operate more efficiently. A few success stories are highlighted below.

The Ecostove in Nicaragua

Three-stone fires often result in burns; can lead to acute respiratory illnesses that are the second highest cause of death in young children in Nicaragua; and are inefficient, requiring lots of wood. The Ecostove, an efficient enclosed stove that was developed in Honduras, has been found to reduce wood consumption and smoke by half. In the Ecostove, the cooking fire is enclosed in a ceramic box encased by an insulated material (such as pumice rock). A metal griddle sits above the fire, and smoke leaves the stove via the chimney. The unit is sealed, so no air pollution enters the building. The stove works well in Central America, where tortillas are a common part of the diet. Tortillas can be cooked on the flat surface of the stove, with no contamination from smoke.

An article in ITDG *Food Chain* that described the Ecostove also shared two case studies of women who prepare and sell food out of their homes. They have benefited financially (because they need to purchase less fuel wood) and health wise (because the smoke from the fire is carried out of the house). (Cameiro de Miranda, *ITDG Food Chain* 31:23-25).

Kenya *Smoke and Health Project*

An ITDG project involved 50 rural households in Kenya. To reduce smoke in the house, the households were introduced to smoke hoods, enlarged eaves (to improve ventilation), windows and improved fuel-efficient stoves.

"Without these aids, smoke particles in the air exceeded 5526 micrograms per cubic metre of smoke; with them pollution is reduced by approximately two-thirds. Personal monitors on cooks showed that exposures to [potentially toxic] carbon monoxide were reduced by 35 per cent.

"'The project identified that the levels of smoke particles in these rural homes is, in most cases, more than 100 times greater than the acceptable level of 50 micrograms of smoke particles per cubic meter suggested by the US Environmental Protection Agency', says Dr. Liz Bates, co-ordinator of ITDG's Smoke and Health Project."

"ITDG is disseminating the ideas to urban areas in Kenya and other countries like Sudan and Nepal." (Smoke Gets in Their Eyes, *Appropriate Technology*)

Other Examples of Stoves

Exposure to smoke is best reduced with stoves that have chimneys, but these stoves are not always feasible. Below are examples of some very inexpensive stoves that result in fewer emissions.

The Jiko is a bucket with a ceramic lining that can be made for US$2.00. Alternatively, a ceramic insert alone can be set in the fireplace and surrounded by mud and stones. The insert can be made for less than US$1.00. More information can be found at http://ces.iisc.ernet.in/energy/paper/tech101/jikostove.html.

Aprovecha developed the Rocket Stove, which consists of a small tin can inside a large tin can, with the space between filled with ashes. Information (including how to make one) can be found at http://members.efn.org/~apro/AT/atrocketpage.html.

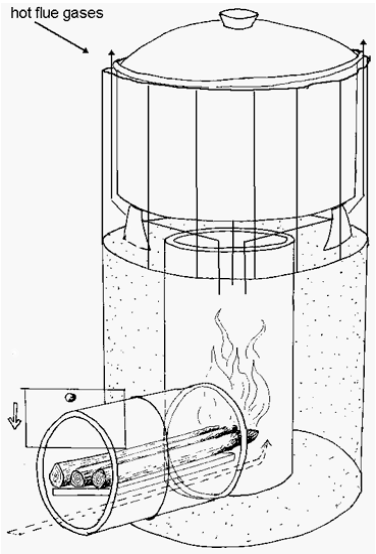


Figure 2: Diagram of a Rocket Stove, including a thin piece of metal wrapped around the pot to nearly double efficiency of the stove. Diagram from http://members.efn.org/~apro/AT/atrocketpage.html.

Full references available on request.

Results of a Moringa Taste Test

By Dov Pasternak, ICRISAT Sahelian Center
Niamey, Niger

Introduction

Moringa oleifera, a tree native to India, is now acclimatized in most tropical regions of the world. Moringa leaves are highly nutritious, containing large quantities of β-carotene (the Vitamin A precursor), minerals and proteins. Moringa pods are an important component in the diet of the India sub-continent.

Moringa leaves are the most popular vegetable in Niger. They are sold and consumed in much higher quantities than tomatoes or cabbage. Moringa is a very important source of income to small-scale farmers and to women who have the monopoly on trading Moringa leaves.

In recent years, India developed a very productive moringa variety named PKM-1. This variety produces a very large amount of pods. It also produces many more leaves than the so-called "local" varieties of moringa in Niger.

IPALAC (the International Program for Arid Land Crops) is a joint activity between the Ben Gurion University of the Negev in Israel and ICRISAT (the International Crops Research Institute for the Semi-Arid Tropics). The main objective of this program is the judicious transfer of plant propagation material between and among the dry regions of the world. IPALAC has established a large plant introduction facility at the ICRISAT Sahelian Center in Niger.

Two *Moringa oleifera* varieties ('local" and PKM-1) and an additional moringa species (*M. stenopetala*) were planted side by side at the Sadore station of ICRISAT. The PKM-1 variety produces by far the largest amount of leaves on an annual basis. IPALAC intended to disseminate this variety in Niger. However this variety was developed primarily for pods. Thus prior to its dissemination in Niger and in the Sahelian region it was found necessary to conduct an organoleptic test (taste test) of PKM-1 in comparison with the local variety. It was decided to also include leaves of the species *M. stenopetala* in this test. Many claim that its leaves are tastier than the leaves of *M. oleifera.*

The Taste Test

Leaves of the three moringas were boiled in water and salt for one hour.

Three populations participated in the test: Field workers at Sadore (25 tasters) represented the rural population; technicians and administrative staff (19 tasters) represented the urban population that consumes moringa; and scientists (8 tasters) represented a population that is not accustomed to eating moringa.

Each participant tasted each of the three moringas, which were labeled as A, B, and C. They were asked to rank the taste of each of the three samples from one to five, with five being very tasty.

The results underwent an Analysis of Variance and are presented in Table 1.

Table 1. Taste ranking of three moringa varieties by three populations (SE=standard error of means)

Population	Ranking of local variety	Ranking of *M. stenopetala*	Ranking of PKM-1
Field workers (farmers)	3.12	1.80	4.72
Technicians (urban population)	2.85	2.35	4.45
Scientists (previously unexposed)	2.38	2.50	4.62
Mean	2.78	2.22	4.60
SE	0.175	0.144	0.098

All three populations clearly and significantly preferred the *Moringa oleifera* PKM-1 variety to the other two moringas. The farmers' population preferred the local variety to *M. stenopetala*, whereas the other two populations did not show any preference between the local moringa and *M. stenopetala*.

Conclusions

The results of this test were a pleasant surprise. They clearly showed that the PKM-1 variety, which is much more productive than the local variety, is also much tastier to farmers and city dwellers who consume the local variety and to a population that is not familiar with this leafy vegetable.

The results of this test therefore open the door for large-scale dissemination of PKM-1 as a preferred leafy vegetable variety.

[Ed: ECHO can provide a trial packet of PKM-1 (purchased from India) to readers working with community development organizations overseas. Others can buy packets for US$3.50 (includes shipping). Larger quantities can be purchased from India by writing to one of the following companies.

Horti Nursery Networks; 25, Raji Medicals Building; 1103, E.V.N. Road, Opp. to Govt. Hospital; Erode, Tamil Nadu; India 638 009; Phone: 0424-261815; Fax: 0424-262919; Nursery: 04257-54697.

Annai Enterprises; Contact Person: Michael Raj 19/4, Pudu Palli Street, Chennai 600 004. Santhome, Tamilnadu India. Phone: 91 44 2462 0505; Fax: 91 44 5210 1596; Mobile: 91 94441 68680, 91 94441 68686; Email : info@annaienterprises.com.]

ECHOES FROM OUR NETWORK

Black Sigatoka

Some time ago, we received an e-mail request from Bruce Robinson. He wrote, "I am an engineer working in Northwest Haiti….most of the plantains and bananas out here have gotten the sickness that the Haitians call Sigatoka. We are about to lose a very important source of revenue and calories. We have heard that there is a treatment that they are doing in the Dominican Republic where they immerse the entire small banana plant in a solution before planting it. Do you know anything about it?"

Danny Blank, ECHO's farm manager, had the following response. "Black Sigatoka is a fungus that in recent decades has devastated the banana industry. The fungus colonizes the leaf and is spread through wind and infected material. There is an excellent description of the disease at the following website: www.apsnet.org/education/feature/banana/ Top.html (we can send a printed or e-mailed copy of this article if you are unable to access it on the web).

"Dipping the corm in a fungicide and/or insecticide solution, previously mentioned as a practice in the Dominican Republic, is a standard procedure for planting non-tissue culture bananas. I think this procedure is more for controlling the spread of the banana corm weevil and panama disease, a widespread soil-borne fungus, than Black Sigatoka. Nonetheless, in my opinion this is a good procedure to follow though it may not help in the control of Black Sigatoka. According to the late Dr. Phil Rowe, once an area has Black Sigatoka it is not possible to rid the area of the disease. However, different strains of the fungus and other diseases and insects may be prevented by this treatment.

"The only recommended control for current plantings that I know of is repeated fungicide applications on highly susceptible cultivars (such as the Cavendish group) or planting resistant cultivars. Since the former is expensive and impractical in smaller noncommercial settings, the planting of tolerant varieties seems to be the only real solution to this particular problem. The FHIA cultivars are recommended as they demonstrate good tolerance to the incidence of both panama disease and Black Sigatoka. Our technical staff can help [members of our network] get in touch with others in Haiti growing these varieties. We can also help find a commercial source for the tissue culture plantlets."

Water Purification

ECHO staff member Bob Hargrave recently participated in an e-seminar on water purification (participants in many locations communicated by e-mail). Here we summarize a few of the items that were discussed during the seminar.

Jacky Foo, moderator of the e-seminar, wrote, "I read [on ECHO's website] about the feedback from Drissa Kone in Mali about 6 years of experience in 15 school gardens in growing and using Moringa as food and medicine. World Vision has also reported on work in Mauritania. Do these local people use Moringa seed powder for clarification of their drinking water?"

Bob asked Beth Doerr if she had done any work with moringa as a coagulant in Mauritania when she and her husband Stan worked there. Beth responded, "I developed the Moringa project for World Vision, Mauritania. The focus of the project was using Moringa as a nutritional supplement but it also covered the water treatment aspect. The staff members were trained in how to use Moringa to treat water and the project planned to begin teaching this aspect to the communities in the second phase of the project (we didn't share that in the first phase because we wanted communities to save all of the seeds for planting). I left before the second phase of the project but I do know that the staff members were very impressed with the results and would use it on occasion when they traveled to communities that didn't have a good water source. It has a lot of potential, especially for countries like Mauritania where water is very scarce. When I lived in Malawi, the government was using Moringa on a large scale to treat the water supply for several of the cities. From what I understand it was a study through a grant and when the people who were doing the study left, the cities went back to using chemicals for their water treatment."

Jacky Foo also quoted the following from our website: "Seed powder can also be used to harvest algae from waste water,

currently an expensive process using centrifuges. Spirolina algae is farmed in Mexico and Israel with minor production in other countries. The spirolina is used in health food and cosmetic products, and it is a common fish food ingredient. Seed powder will cause the algae to sink to the bottom." Foo added, "The lack of simple and cheap methods for harvesting microalgae has been a major constraint in the use of algae in feeds. Moringa seed powder could be the answer to this problem."

BOOKS, WEBSITES & OTHER RESOURCES

Access to Global Agricultural Research

We read the following in *Spore* 110 (April 2004 issue): "Gaining access to updated scientific information has long been a battle for anyone based in the developing world. Equally difficult has been the task of finding an outlet to publish findings, or a source for updating teaching curricula and identifying funding. The Access to Global Online Research in Agriculture (AGORA) aims to fill the gap by providing free or low-cost access to major scientific journals in agriculture and related biological, environmental and social sciences to public institutions in developing countries. Led by the Food and Agriculture Organization of the United Nations (FAO), it offers access to over 400 journals from the world's leading academic publishers. Free access is available to most countries with an annual per capita gross national product of US$1,000 or less."

A list of eligible countries is found on AGORA's website at www.aginternetwork.org. Within these countries, eligible institutions (whose staff and students may access the journals) include universities and colleges; research institutes; agricultural extension centers, government offices and libraries. In order to access AGORA, participating institutions will need computers connected to the Internet with a connection of 56k baud rate or higher. The system is designed to work best with Internet Explorer version 4.0 or higher, or Netscape version 6 or higher. Users will also need Adobe Reader (which can be downloaded for free from www.adobe.com/products/acrobat/readermain.html) for journal articles in PDF format.

To join AGORA, someone from your institution will need to complete the online registration form (found on their website, above). Then your institution will be sent an agreement to sign regarding terms of use and instructions for getting started.

For institutions that do not have adequate Internet access for AGORA, another option is The Essential Electronic Agricultural Library (TEEAL), a collection of key agricultural journals available to developing countries on CD-ROM. Although greatly reduced, the cost of TEEAL is still high. The TEEAL website lists potential donors that could help in purchasing TEEAL. Website: www.teeal.org/

Food Science Online

The following is also from *Spore* 110: "New developments in food science and technology are charted in Food Science Central, a major food information portal and one well worth bookmarking. Registering is free, and a quick and efficient search facility turns up material from a vast gamut of sources, on topics ranging from food safety to storage. The service is constantly updated, so visitors can get the latest developments on hot topics such as Genetically Modified crops (GM crops). A valuable feature of this well designed site is the searchable Internet Links database, a selection of more than 2,800 of the best food and nutrition websites available on the Internet." The website address is*:* www.foodsciencecentral.com"

FROM ECHO'S SEEDBANK

Carambola—A Five Star Fruit

By Grace C. Ju, PhD
Seed Bank Manager

Star fruit or Carambola (*Averrhoa carambola* L.) is one of my favorite tropical fruits. My children love to pick these fresh off the trees and eat the delicious and nutritious fruit, which does not need to be peeled or seeded. It makes a great dooryard tree. The trees bear prolifically (up to 250 lbs of fruit a year), but do not get very tall so the fruits are easy to reach. The fruit gets its name from the five-pointed star shape that is seen when it is cut across the middle. When ripe, it is a golden yellow and has a smooth waxy surface. It is an excellent source of vitamin C, with one fruit providing 45% of the Recommended Daily Value.

Carambola is an excellent fruit to grow in the tropics because it has prolific fruit production, high nutrition, almost continuous fruiting, wide appeal and is very adaptable to different soils and locations. Most amazingly, it bears fruit only 2-3 years after planting from seed! It bears 6-8 months out of the year, sometimes even 12 months in the wet tropics. Carambola has great potential in improving nutrition and income in many communities.

The carambola is originally from Sri Lanka and the Moluccas and is widely cultivated in Southeast Asia. It is also called bilimbi, Chinese star fruit and star apple. Today it is also cultivated in Africa and the Americas. It is a handsome, slow growing tree that seldom exceeds 25-30 feet in height. Its canopy is broad and round. The carambola is classified as a tropical tree although mature trees can tolerate temperatures as low as 27ºF (-2.8ºC) for short periods of time. Young trees need to be protected from cold wind.

Although it can grow in many different kinds of soil, it does best in rich loam. It

is harmed by waterlogged soil and its leaves start to yellow in alkaline soil. The tree needs ample moisture for the best growth. Because it is a small tree, you can protect it from frost. A spacing of 20 ft is recommended for plantings. It grows at up to 4000 ft. elevations. Pruning by cutting the terminal ends of the branch can extend production, and removing all leaves and lateral shoots can induce off-season flowering. There are no serious pests or diseases except for fruit flies. The carambola can be grown from seeds but the seeds are viable for only a few weeks and viability declines steadily. Plant only fully developed seeds.

Trees from seeds will show a wide variation in fruit color and sweetness. You should graft sweet varieties to seedling rootstocks. Chip-budding is a method used in Florida nurseries: buds are collected from ¼ inch diameter wood and grafted to rootstocks of the same diameter. In veneer grafting, healthy year-old seedlings ¾ inch in diameter are best for rootstocks. Graft wood is taken from mature twigs with leaves present and with some buds. Cleft grafting of green budwood can also be used. The length of time until the first crop is about 2-3 years from seed.

Figure 3: Ripe carambola fruits hanging on a tree. Photo by ECHO Staff.

The fruit ranges from tart to sweet. There may be 6-12 flat seeds in each fruit. The fruit is best ripened on the tree but can be picked green to ripen on the shelf. You may want to trim each rib and remove the darker green edge, which can be bitter. It has a slight oxalic acid flavor. The carambola fruits can be easily damaged so care must be taken in packaging and storing. They can be stored at room temperature for two to three days and refrigerated in a bag for up to a week. Fruit can be eaten as part of a salad; used in chutney, tarts, and preserves; or dried. Slightly under ripe fruit can be used in pickling or jams. Carambola makes a refreshing beverage. In China it is made into a sour juice that is used to help relieve sore throats. Our ECHO interns have made carambola breads, muffins and a delicious star fruit "upside down cake"!

There are several varieties of carambolas. Our seed bank has seed available from Arkin, Sri Kembangum, Bell and Kary varieties. Since these seeds do not come true to seed, after the trees bear fruit you should select the ones with sweeter fruit to be propagated by grafting. Seeds should be planted as soon as they are received. With the potential of one tree producing up to 250 pounds of fruit per year, this fruit is truly a star! Give the tree lots of sun, moisture and rich soil and it will give you lots of tropical delights!

Those working in agricultural development in developing countries may request one free sample packet of mixed carambola seed. All others may purchase the seed from ECHO. The overseas price is $3.50/packet and the domestic price is $3.00/packet. Carambola seed is available seasonally.

UPCOMING EVENTS

Important Information about ECHO's Agricultural Missions Conference

ECHO, Fort Myers, FL, USA
November 9-11, 2004
By Martin Price, Executive Director

A few people told me that they are not coming to ECHO's conference this year because "it is about development work in northern climates." This is a serious misunderstanding of what we wrote. ONE of the sub-themes, an important one, this year is northern development work. There will be a few talks to the whole group on this subject and probably one concurrent evening session. But most delegates work in the tropics and that work will still be the major emphasis at the conference.

Hurricane Charley narrowly missed ECHO. The eye passed about 30 miles (48 km) north of us. We are still in fine shape to host the conference. ECHO lost some of its largest trees, but these trees were of marginal importance. All buildings and plantings are intact. We have a contract for 95 rooms in the hotel. If the present shortage of hotel rooms caused by the hurricane continues, we might not be able to get additional rooms for last minute registrants. So apply soon and call if you decide at the last minute to come to make sure we can house you.

Correction about Workshop on Health, Agriculture, Culture and Community

ECHO, Fort Myers, FL
November 15-19, 2004

We announced this workshop in July's issue of EDN, but please note the correction in dates. The workshop will take place from November 15-19, rather than November 15-17. We apologize for the error!