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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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Gray Water and Crop Irrigation

By Larry Yarger and Dawn Berkelaar

In areas that are dry, or during times of water shortage, it makes sense to reuse water if possible. We have heard the mantra "Reduce, Reuse, Recycle." Use of gray water (GW) is one way to do this. During a drought, when most fresh water is needed for drinking, GW may be the best water alternative for gardening.

"Gray water" (also "grey water," "graywater" or "greywater") is the term used to describe wastewater from dish washing, laundry, bathing, and rinsing. (Note: the term gray water does *not* refer to toilet waste, which is often called "black water.") Although gray water does not need extensive treatment before it is used for irrigation, one must be careful as it can contain grease, hair, detergent, dead skin, food particles and occasionally fecal matter.

Gray water, when applied to the soil, simultaneously supports plant growth, recycles nutrients, and is itself purified through biological activity in the soil. Gray water for gardening could even reduce the use of harmful chemicals; a person might be less likely to dump toxic chemicals down the drain if gray water were used for irrigation.

This article addresses agricultural, human health and environmental issues surrounding the use of gray water.

Gray Water on Soil and Crops

In many cultures where there exists a need to conserve water, people use gray water on kitchen gardens, container-grown crops and various trees and shrubs growing around the home.

Andre Schmidt with the Mennonite Central Committee in an arid region of Nicaragua wrote in June, 2001: "As water is in very short supply during the long dry season, all water sources are used for watering plants, seedlings, and vegetables around the house. Is soapy water (from bathing and washing dishes) harmful to plants? My guess is that the plants most likely to be harmed by soapy water are those grown in enclosed containers (like in pots or old tires) in which the soap collects without eventually being washed out."

ECHO shared how one person had filtered GW through sand before irrigating. Another had used GW to directly water flowerbeds, with very good results. The question was also raised about phosphorus in the form of phosphates (PO_4^{3-}), which sometimes are added to detergents to promote foaming but end up in the GW. Phosphorus is a type of fertilizer (the "P" in NPK is "phosphate") and is beneficial to plants (but damaging in creeks and ponds in high amounts). Phosphates are no longer prevalent in soaps and detergents.

When working with gray water on a residential level, potential problems boil down to three basic issues: salt buildup, soil pH and pathogens (disease carrying microorganisms).

Any negative effects of gray water on plants are largely related to disease organisms (e.g. from laundry) and the types of cleaning products we use. These cleansers are usually soaps and detergents used in personal hygiene, laundry, household cleaning and kitchen chores.

Although soaps and detergents are biodegradable, many contain high levels of sodium (Na). Sodium laureth sulfate (SLES) and sodium lauryl sulfate (SLS) are ingredients now used to promote foaming in place of phosphates, and sodium from these compounds can be linked with problems in soil structure, salt buildup and pH. We would not expect this to be of much concern under normal household use, especially in rural areas of developing countries. It is possible that this could become a problem at an institution (e.g. if a garden at an orphanage is watered primarily from the laundry section). Just be aware of the potential in case a problem becomes apparent.

Too much sodium may cause soil to become hard and compacted. Compaction can cause rain and irrigation water to stand on the soil surface and not enter into the root zone. Elevated pH levels can "tie up" certain soil nutrients making them unavailable to the plant.

The accumulation of sodium salts (such as sodium chloride (table salt) or sodium sulfate) in the root zone reduces the amount of soil moisture available to plants and may cause *wilting*. Salt buildup may also prevent absorption of nutrients from the soil, resulting in *nutrient deficiencies*.

Tips on Gray Water Usage

One solution to salt buildup is to leach out the salts by irrigating heavily (when water is available) to dissolve and wash salts out of the soil. As Andre suspected when he asked ECHO about gray water, this is especially important when gardening in containers. When watering containers, even with gray water, do so until water flows out the drainage holes.

Due to the small amount of GW used on a small farm in a rural developing community, it is doubtful that home application of gray water to the soil would cause salt problems. Even so, the following sections describe complications you might encounter.

Cleansers with chlorine (i.e. bleach) can be toxic to plants, but household levels of bleach generally cause no problems when GW is applied to medium and fine textured soils. On coarse sandy soils with little to no organic matter, you may see root or leaf damage. Use ammonia instead of chlorine bleach for scouring or cutting grease. Use oxygenated bleach for laundry (the type recommended for colors). Use baking soda (sodium bicarbonate) sparingly (e.g. for scouring), especially if you have alkaline soils.

Avoid the use of cleansers or detergents with boron (i.e. borax or boric acid). Water with added borax may apply an excess of the micronutrient boron (B). Boron is needed only in trace amounts, and can be damaging in excess. (Note: citrus, avocado, persimmon and stone fruit trees are *very* sensitive to boron toxicity).

Clean drains with boiling water, oxygen bleach (not chlorine) or dilute hydrochloric acid (available in many pharmacies, hardware, swimming pool or paint stores) rather than lye-based drain cleaners.

Avoid detergents with "softening power," as these contain a large portion of sodium compounds. And although one is not likely to encounter this in rural communities, stay away from "soft" water, as it is "softened" with sodium ions.

If your soil becomes alkaline (pH of 7.5 or higher) as a result of using gray water for a while, there are several minerals that will become unavailable to the plant (particularly iron, manganese, zinc and phosphorus). A soil pH changing to greater than 7.5 may also indicate that sodium may have accumulated from the detergents. Though gypsum (calcium sulfate) treatment can help, that is not a realistic approach for most of our readers.

On the other hand, acid soils (pH less than 7.0) would welcome gray water (unless, of course, you are growing acid-loving plants). We recommend cleaning agents that are generally either acid or pH neutral, though most cleaning agents seem to be alkaline in nature. Mulching with leaves high in tannins, or acidic in nature, will help reduce pH.

If in doubt, consider discharging the GW into a compost pit or pile. The compost will function as a filter, and the biological activity already taking place in the compost will break down potentially harmful gray water components. The extra moisture will also speed up the composting process. This way you will still conserve the moisture in the soil. In general, soil organic matter (OM) functions as a buffer against strong changes in soil pH, such as those potentially brought on by GW. More OM is typically better for your soil.

The University of Massachusetts recommends this "rule-of-thumb" for deciding how much gray water to use on your garden: "A square foot of well-drained loamy soil can handle about a half gallon of gray water per week." Thus in 500 square feet of garden space, you can use about 250 gallons of gray water per week (about 1000 liters per 50 square meters, or 200,000 liters per hectare per week) (www. umassdroughtinfo.org/home_and_garden/gray_water.htm).

The literature states that few materials in gray water cause harm to trees and shrubs when applied to the soil. The alkalinity of GW can corrode the bark of both roots and trunk, but the soil protects the roots. When irrigating trees with gray water, focus the GW on the (well-mulched) root zone, and prevent direct contact with the trunk.

Avoid rinsing the following down the drain: solvents, oils, paint thinners, and petroleum products or organic compounds used in vehicle maintenance or cleaning. These will cause the "failure" of a gray water system.

Irrigation is the most obvious use for gray water. However, irrigation needs are often seasonal. When it is not needed for irrigation, gray water can also be used to flush toilets. Do *not* put gray water into your toilet tank; it will stink. Instead, pour it directly into the toilet bowl using a bucket. This works well whether you use a western-style "sit-down" or a "squat" toilet.

Gray Water Systems

A bucket is the simplest, least complicated way to distribute gray water. Where gray water is used in large amounts (larger than throwing out the dishwater and the semi-weekly laundry water), for example at an institution, one might consider developing a system to treat and utilize gray water. Such a system might include a settling tank to remove solid particles, an oil trap to contain oils and grease, and a biological purification system utilizing soil, soil microorganisms and plants to further clean up the water.

Finca Agape, el Centro Desarrollo Agrícola in Honduras has published a brochure describing a system in which gray water passes through an apparatus similar to a three-chambered septic tank. The GW enters near the top of the first chamber and spills over a barrier into a second chamber. Heavy particles sink to the bottom of the first tank. From the second chamber, the water flows under a wall into a third chamber and exits from that tank. The third chamber catches oils and floating debris to be collected and discarded.

From the third chamber, the gray water flows into a separate tank where it "irrigates" plants (such as water hyacinth, papyrus and cattails) growing in sand. At the bottom of this tank, under a layer of gravel, is a perforated pipe that collects the treated water, which may be used for irrigation. It takes 2 to 3 days to complete the cycle, although "fresh" GW is added regularly. Approximately 20% of the moisture is lost due to evaporation in the process. There is ample room for adaptation to the needs of the individual household or institution.

A system developed in Senegal to treat GW uses open ponds planted with water lettuce (*Pistia stratiotes*), which encourages the growth of microorganisms that feed on the organic material in the water. Research has also demonstrated the use of water lettuce as a high-protein fodder for livestock, although it is considered invasive in some areas.

For gray water to be stored more than three hours, the University of Georgia extension service (http://interests.caes.uga.edu/drought/articles/gwlands.htm) recommends disinfecting, due to health hazards present in particulate matter and detergents. More harmful bacteria are present in standing GW than in fresh sewage. A chlorine concentration of 0.5 ppm will disinfect GW. This can be obtained by adding 0.2 ml of bleach (~10 drops) to a 20-liter (5-gallon) bucketful. Left standing overnight, the chlorine dissipates. The chlorine in laundry water is too dilute to be a useful disinfectant. Aeration and exposure to sunlight will also disinfect gray water so it can be safely stored. Old or unaerated gray water quickly becomes anaerobic and may generate hydrogen sulfide and other offensive gasses.

Human Health and the Environment

As with many aspects of living and working in a rural agricultural setting, gray water can expose humans to potentially harmful elements. Most farmers know, for example, that animal manures can carry disease organisms, and we need to be careful how we manage this rich resource. We should consider GW in a similar light. When properly handled, GW is a valuable and safe resource. If misused, GW can spread typhoid, dysentery, hepatitis, cholera, giardia and other bacterial, protozoan, nematode and viral diseases.

Although chemically inert, the insoluble debris (organic and inorganic) is usually the carrier for most pathogens in gray water. Green Plumbers' website states that GW contains "large numbers of bacteria that may include disease causing microorganisms," although this was not specifically quantified (www.greenplumbers.com.au/index.php?pageID=41). Contaminants documented in polluted water include (among others): *E. coli, Vibrio cholerae* (cholera), *Salmonella* typhii (typhoid fever, food poisoning), *Candida, Aspergillus* (aflatoxin), *Giardia, Cryptosporidium* and *Entameba histolytica* (amebic dysentery). These may also be found in GW, depending on the source of the GW. For example, is river or canal or pond water being used for washing?

Fecal matter contains the largest concentration of pathogens. So if GW contains water used to clean diapers or soiled bedclothes, at least *E. coli*, and potentially all of the above pathogens will be present in the GW. In such a case, the GW should be passed through a GW system, and *not* used to irrigate directly. The simplest technique would be to pass this GW into an active compost pile or pit to disinfect it.

Gray water is naturally disinfected on the soil surface by oxidation and sunlight (UV) exposure, and soil microbes further deactivate harmful compounds and microorganisms, although this process takes time.

The virus content of GW is still a topic under intensive study. Viruses are probably the main impediment to human contact or direct human use of GW. Much has yet to be learned here.

Irrigation of vegetables and forages with gray water is widely debated. Articles written for use in the United States (which tend to be extremely cautious) warn against using GW to irrigate vegetables—only fruit trees and ornamentals. Reports say that it is "unsafe," especially for root crops and leafy vegetables. However, an article in *Spore* (Number 114, December 2004) lauds the use of GW on vegetables in Senegal and reports how it has increased production there.

Penn State University recommends that, rather than on leafy vegetables, gray water be used on *fruiting* vegetables (e.g. tomatoes), particularly those that have been mulched heavily between the rows (the latter would be less likely to make actual contact with GW). Organic mulch filters the GW, retains moisture, and increases decomposition of wastes. Use GW only on established plants, as seedlings are sensitive. We have yet to find a qualitative analysis of GW as it relates to leafy and root crop vegetables, but unless there is a significant time lapse and adequate sunshine and rainfall are anticipated, such direct application of GW is questionable.

There is little concern about contaminating groundwater with gray water. However, it is good to discharge GW into the soil or a compost-filled basin if not collecting it for irrigation. Locate your GW treatment area as you would a latrine. Keep it well away (at least 10 meters) from your well or water source.

Personal experience in nations around the world and a lack of literature to the contrary is evidence that farmers, although not extensively, do irrigate with gray water and without major health problems. In the US, although under different cultural and economic pressures, there has been no documented case of sickness or disease from GW use. In some places, water of questionable origin that is sprinkled on fruits and vegetables to "freshen" them up for sale in the market poses greater risk of sickness than irrigation with the same water.

Especially in the tropics and subtropics, note that mosquito-borne diseases may increase if standing water (gray or otherwise) is allowed to accumulate where you irrigate.

Conclusion

The use of gray water is a technology with tremendous potential. Through our review of the literature, we have found that we can make some general recommendations:

- GW is especially valuable in dry climates where water is not readily available, is expensive or must be carried considerable distances.
- GW recycling is a well thought out system of discarding wastewater to reduce potential disease danger and environmental pollution.
- If you have a concentrated source of disease organisms for your GW, such as dirty diapers, treat it more like black water. It needs exposure to UV, oxygen (O_2) and soil microorganisms.
- Organic matter in the form of compost and mulch is important to buffer the potential alkaline nature of GW, break up the potential soil compacting properties of salts and sodium-containing compounds, and promote the growth of microorganisms to break down and deactivate harmful compounds in the GW.
- Be aware of the cleaning products you use, as some plants may be sensitive to the ingredients, as well as to the alkaline nature of the GW.

Set up your gray water system carefully in the context of your needs and resources. Maintain it as you would any other aspect of your farm, and such a gray water system potentially will become an added resource and otherwise a blessing!

Hybrid Maize Revisited

By Bob Hargrave

Over the years ECHO has been asked to give advice concerning whether or not to use hybrid seed. We carry very few hybrid varieties in our seed bank because we expect people who receive seed to multiply it locally. Now some new information about this old question, specifically about maize, has come to our attention.

In an article in *EDN* 64, we discussed the effect of introducing hybrid maize seed in Nicaragua after hurricane Mitch. Farmers in that area had traditionally used open-pollinated (OP) maize varieties and saved their seed. There was concern that introducing hybrid maize varieties might contaminate the local maize.

We concluded: "Assuming that the new hybrid was adapted to the growing conditions in Nicaragua, planting it should not result in disaster—in fact it may confer some genetic material to existing varieties that would prove beneficial."

There is now evidence that this has in fact happened in Mexico through a process called "creolization." We found information about it in a paper from the International Food Policy Research Institute (IFPRI) titled "The Impact of Improved Maize Germplasm on Poverty Alleviation: The Case of Tuxpeno-Derived Material in Mexico" (Mauricio R. Bellon, *et al*. Food Consumption and Nutrition Division Discussion Paper No. 162, IFPRI, 2003.)

The Research Method

The study was undertaken to determine how farmers in lowland tropical Mexico use improved maize germplasm, and if it was helping to alleviate poverty in selected communities in Oaxaca and Chiapas. Farmers were found to use improved varieties, traditional varieties (commonly referred to as landraces) and varieties that they recognized as crosses between hybrids and landraces (these crosses were called "creolized" (acrillado)).

For 40 years the government has promoted improved varieties of maize—both hybrid and open-pollinated. Recent traditional studies that focused on comparing traditional with improved varieties found that only about one quarter of the maize planted in the country was of an improved variety.

In this study the researchers, taking a social science approach, asked farmers to classify their maize seed more broadly. They asked what characteristics other than yield were important to them. The results were also analyzed among different income levels: "extreme poor," "poor" and "non-poor."

The researchers found that farmers classified maize seed into two broad groups: either "variety" maize, that is, seed from a bag; or "creole" (criollo), a term that includes recycled, creolized and traditional land races.

However the farmers do recognize that "variety" maize will become "creolized" over time to become "creole" or traditional. The authors were able therefore to confidently classify the maize seed planted as: 1) Hybrid (from a bag); 2) Recycled hybrid—hybrid seed that has been saved and replanted up to 4 years; 3) Improved Open Pollinated Varieties (from a bag or recycled for up to 4 years); 4) Creolized—recycled from 4 to 15 years; or 5) Landrace—not from a bag, planted for many years and usually bearing the name of a known race of maize.

The poorer farmers in Oaxaca tended to use creolized and landrace varieties more than improved varieties. In Chiapas, about half of the acreage of poor farmers was planted to creolized and landrace maize. The two main reasons given were economics and confidence levels. Farmers expressed more confidence in the landraces and creolized varieties than in the improved varieties, because they had seen the former growing and felt they had become acclimatized. These varieties were saved from one season to the next, sometimes traded socially, and if purchased, were significantly less expensive than seed sold in bags.

The Creolization Process

Maize became creolized over time through crossing between varieties that were planted near each other. Sometimes, but not often, this was done deliberately.

Improved varieties also became creolized as farmers saved seed from fields sown to those varieties. Scientists referred to this process as “recycling.” Both hybrid and OP varieties were found to be recycled. A variety that had been recycled more than 4 years was considered creolized, and after 15 years became a traditional landrace variety.

Conclusions

The research team concluded that improved varieties of maize do eventually benefit the poor farmers because the local varieties are improved through the process of creolization. Some of the implications of this conclusion are:

1. Introducing improved varieties of maize is a good thing—as Dr. Hallauer was quoted in *EDN* 64: “the introduction of new genetic material may…improve the performance of the local open-pollinated varieties.”
2. Characteristics other than yield need to be considered in comparing maize varieties in field trials and in selecting seed for maize improvement efforts. Some of the more important characteristics identified by farmers in this study were resistance to lodging, ease of shelling and yield of dough (masa) when making tortillas.
3. Maize breeding does not stop when a variety is released. This phenomenon has also been recognized in the recent emergence of “participatory plant breeding” as a crop improvement strategy.
4. Any maize extension program should include a component that helps strengthen the ability of the farmers to deliberately identify and select for traits that are important to them.
5. Do not rule out hybrid seed corn just because farmers may not be able to continue purchasing seed. Farmers will likely not have serious problems if they save seed from the hybrid varieties. Importantly, some of the superior genetic traits will be passed on to local varieties planted nearby. With careful annual selection of the best corn for seed, gradual year-to-year improvement in “creolized” local varieties is quite possible.
6. Help farmers learn to explain what qualities are most important to them and then help them learn how to select for those traits. (see *Amaranth to Zai Holes,* pp. 77-78)

Where can you get improved seed? Whenever possible, try to test varieties promoted by the national research institute of your country, even if they are hybrids.

Another option for trial-size quantities of maize seed is to contact CIMMYT, the international research institute in the CGIAR system responsible for maize. Tell them what organization you work for and what in particular you are looking for. The more specific you can be about the climate, soil and other environmental conditions or any specific problems farmers are facing with maize, the better they can help. Contact information: CIMMYT; Apdo. Postal 6-641; 06600 Mexico, D.F., Mexico; Tel: +52(55) 5804-2004; Fax: +52(55) 5804-7558.

What about Hippos?

By David Balsbaugh

We have written in past *EDN* articles about many different garden pests, ranging from sneaky monkeys to magnificent elephants and even to hungry iguanas. Well, what about hippopotamuses? Yes, you heard right, HIPPOS! Believe it or not, on the banks of Lake Victoria and Lake Malawi and at river edges in Eastern and Central Africa, hippos are a major garden pest. Can you imagine how many plump cabbages or juicy red tomatoes a hippo can eat in one single night? How do we stop these hungry hippos? We have some techniques to share, but first you need to know a bit about this opponent.

Hippos stay near water, but at night they may travel some distance in search of vegetation, often feeding on cultivated crops. An adult hippo can eat up to one hundred fifty pounds of vegetation a day! WOW!

Hippopotamuses kill more people in Africa than any other animal. Male hippos are known to be very territorial. When a hippo attacks a person in the water, it will typically grab the person with its large teeth and take him under until he drowns. However, most hippo attacks occur on land. It's tempting to think that these large animals are slow and clumsy, but in fact they are quick and will easily trample a person if he gets too close. Be very careful when trying any type of control method that requires you to be near to a hippo.

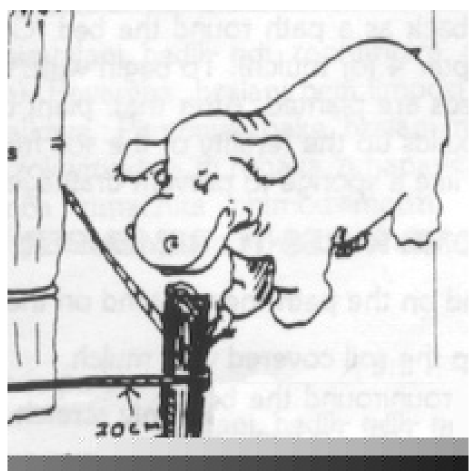

Figure 1: A strand of wire, placed around a garden about 20 cm above the ground, deterred hippos.

I worked for several years in Malawi, Africa, with a community agriculture project near a place called Monkey Bay on Lake Malawi. One common problem people experienced was hippos eating garden crops at night. During this time I met June Walker of the Permaculture Network, who shared with me one possible hippo solution. We noticed that hippos would go through just about any fence or deterrent. However, one strand of firmly fixed wire around the garden, placed about 20 cm above the ground, did in fact deter hippos (Figure 1). We have no scientific explanation of this, other than that it seemed to confuse the hippos and they would move on to another garden. This appeared to work as long as there were other gardens to feed on. When the dry season came and the enclosed garden was the only green vegetation, the hippos found their way through the wire. The method only worked as long as there were other things around for the hippos to eat.

I tried this method again in Mozambique along the Zambezi River at a demonstration farm. I decided to use the wire again, but added something that would possibly throw off the hippos' scent of our vegetables. Since hippos are vegetarian, we strung a few small fish on the wire around the garden. We observed that the hippos would come to the garden, smell the fish and leave. We assume that the smell of the fish masked the scent of the vegetables and discouraged the hippos. I know that the smell discouraged me from going to the garden, especially after the fish had been on the wire for a week! From then on we used this method, at least around small gardens. We collected fish waste after meals, since we didn't want to waste good fish to use as a hippo deterrent.

For a long-term solution suited for larger areas, we planted giant sisal (*Agave sisalana*) every meter. Even though hippos have a fairly thick hide, their eyes are unprotected from the thorny interlocking sisal leaves. Though it can take up to three years depending on rainfall to establish a good sisal stand, this solution proved best for our situation.

Paul Noren, a recent visitor at ECHO who works in the Congo, used ironwood posts placed every 70 cm as a control method. These posts should be at least 40 cm in diameter and must be dug into the ground at least 60 cm. This method works well where wood is not scarce. Paul also saw trenches dug around the garden that are one meter wide and one meter deep. It appears that hippos are not inclined to jump that far.

Lance Edwards, a former staff member at ECHO who grew up in Zimbabwe, told of a very interesting technique for deterring hippos. His father made a simple device that triggered a shotgun shell to explode inside a steel pipe pointed into the ground. When a marauding hippo came after his crops and triggered the trip wire, this would set off the shell with a loud bang and scare off the hippos.

If you have any experience with keeping hippos and other large animals away from crops, we would like to hear about your successes so that we can share them with our network. If you decide to try any of the ideas mentioned here, or if you have a tested hippo solution, let us hear from you!

ECHOES FROM OUR NETWORK

Feedback on Cooking Stoves Article (*EDN* 85)

Dan Hemenway from the Barking Frogs Permaculture Center wrote, "Thank you for the excellent article on smoke and cook stoves. As someone who has heated with wood for 30 years and who cooks with wood fire for half the year, let me underscore what I see as the major points.

"First, the editor's note on smoke as an insect repellent needs underscoring. When I gave the first Permaculture Design Course in Ireland, one of my students related to us that when efficient cook stoves were introduced in a part of the Sudan, the incidence of malaria skyrocketed. If you change one thing in an established culture, do not be surprised if many unanticipated effects ensue. Naturally, in such instances we need to introduce solutions to insect control along with stove introductions. We need to look at the whole living situation.

"Two main measures are required to all but completely eliminate smoke from wood fires. The first, and most important, is to use extremely dry fuel. Alas, this will be hard to implement where people live hand to mouth in all ways, and where a stockpile of fuel is likely to be stolen if it hangs around for a while. The second is the correct draft, or airflow, to keep the fuel burning hot and thoroughly. Smoke is wasted fuel. Species of wood is less important than these two factors.

"It is also important to control the [heat] of the fire by selection of species and quantity of wood used. Fuels with a low heat value will not smoke if burned with plenty of oxygen and a good draft. Shutting the damper to control heat, instead of building a fire of the correct size and species, results in smoke. If the smoke goes out the chimney, then we substitute outdoor pollution for indoor pollution. This is also undesirable.

"Correct draft is a function of stove and flue design. There is no point in designing a general efficient stove; we need to adapt each design to local materials, technology, and aesthetic values. I once showed a picture of a parabolic solar cooker to a group in Mexico, and the women all said that they would not use it. In 5 minutes, with feedback, we designed a stove based on the same principles that they would use.

"While solar stoves clearly are a major step in the right direction (with appropriate attention to insect protection, e.g., making screens and mosquito netting available), in most climates they cannot completely replace wood, dung (alas) and other biomass fuels. In my opinion, only someone living in the area, developing stoves from the shared experience of the community, and using such a stove personally has a high probability of making significant inroads on this serious problem."

Dr. Ed Nesman wrote to us about the same article. "I read with a great deal of interest the article on "Indoor Air Pollution from Cooking Fire Smoke," and particularly the section on the Ecostove in Nicaragua.

"In the 1980's I was a member of the evaluation team that measured the impact of these stoves that were part of the Proyecto de Tecnologia Rural in Honduras. I am enclosing a few short paragraphs from the summary report that was submitted to USAID and the Honduran Government [excerpted below]….The savings in wood in one year was estimated at nearly one million dollars in addition to the impact on conservation of resources. Of all of the technologies studied, the stove had the greatest impact."

- 144 respondents reported using the improved stove technology. Three indicated that they had discontinued using the stove but the remaining 141 were presently using the stoves.

- Those who had adopted the new stove technology reported considerable saving in fuel. Previously, the average weekly use was 140 "lenos" (standard sticks of fire wood). This was reduced to an average use of 58 "lenos" with the improved stove. Considering the average time of stove use in months, each person in the sample that used the improved stove saved an average of 14,581 "lenos." This represents a considerable saving, both from a monetary point of view as well as in natural resources.

Low Fertility Soil and Traditional Varieties

Joel Matthews received some feedback about his comments on low fertility soil and traditional varieties in *EDN* 86. In response, he sent the following additional comment.

"I must emphasize that increasing soil fertility, organic content, and mulch cover is a good idea *in most cases*. Agriculture cannot be reduced to a single set of conditions/solutions applicable everywhere, lest we become purveyors of agricultural ideology rather than true science.

"There are certain environmental conditions, fairly common in West Africa, where the standard solutions can be detrimental. In these conditions it is best to recommend partial conversion of farms to high fertility/mulching, to allow maximum exploitation of extreme seasonal fluctuations; traditional long- season cereals on low fertility sandy sites will outperform during very low rainfall years, and improved short-season cereals will outperform on high fertility sites during years of adequate rainfall.

"Since a moderate organic mulch cover can absorb most of a 5mm rain, dirt mulch, which absorbs nearly 100% of light precipitation, is substituted for the very low rainfall contingency."

Aflatoxin in Peanut Butter

The University of Zimbabwe (2002) studied the presence of aflatoxin in peanut butter. Among four different methods of processing (traditional, hand, motorized, commercial) traditional methods consistently had the lowest concentrations and commercial processors consistently had the highest concentrations of aflatoxin.

Samples were taken in January, April and August. All peanut butter samples processed traditionally had aflatoxin concentrations below 20ppb (the level that formal markets have set for aflatoxin contamination). Commercial peanut butter had the highest number of contaminated samples (93.75%).

Generally, all processing methods showed some percentage of undesirable aflatoxin levels, indicating the need for education on aflatoxin awareness.

Aflatoxin levels were highest in the January samples, with a reduction during April and August (except for commercial processing), indicating a possible seasonal fluctuation of aflatoxin in storage.

The lower levels of aflatoxin in traditional and hand processing could be due to the use of quality nuts, and to more thorough selection (since low volumes of nuts are used).

Two possible reasons for high aflatoxin levels are the use of poor grade nuts and poor storage from the time of purchase to processing.

Aflatoxin occurred across all natural regions, suggesting that weather conditions are not a determining factor.

Reference: Improved Peanut Butter Processing. University of Zimbabwe, 2002. Part 4. Prevalence of Aflatoxins in Rural Small Scale and Commercial Production. pp 82-89.

Invitation to Join Web Forums

ECHO's website includes several forums where members of our network can post messages and share information on various topics. One forum is called "Interaction on *EDN* articles." If you have feedback to offer regarding previous *EDN* articles, this would be a great place to share it! We would especially like to hear feedback regarding the articles about smoke from indoor cooking fires (*EDN* 85) and aflatoxin (*EDN* 87).

BOOKS, WEBSITES & OTHER RESOURCES

Helpful Publications Available for Download

Mr Alex Weir, a contract software developer in Harare, Zimbabwe, has made us aware of a website with access to many free agricultural publications. Over 800 technical publications useful for agricultural development work are listed. www24.brinkster.com/ alexweir/CD3WD/index.htm.

All 180+ VITA publications listed on the website can be accessed alternatively in their French, Spanish, Portuguese, German or Italian versions.

More Helpful Websites

African Journals OnLine (AJOL). www.ajol.info. This website provides access to African published research. 215 journals are now on AJOL. Access to all online abstracts is free, and full text articles can be ordered. People outside of developing countries must pay for document delivery requests.

Simbani Africa, a radio-based news agency focusing on development issues in Africa. http://simbani.amarc.org/en/. Material from this news agency is available on the Internet in French and English. You can search the network by theme: HIV/AIDS, Environment, Food

Security, Gender, or Human Rights and Democracy.

Intermediate Technology Development Group (ITDG). www.itdg.org. Over 100 Technical Briefs are available online as pdf files, in categories that include energy (e.g. biomass; biogas), water and sanitation (e.g. solar distillation), manufacturing (e.g. recycling of plastics), and food processing (e.g. drying technology; tofu and soymilk production).

FROM ECHO'S SEEDBANK

The Chocolate Pudding Tree: *Diospyros digyna* (Black Sapote, Black Persimmon, Zapote Negro)

By Dr. Grace C. Ju, Seedbank Director

Paul Noren, a recent visitor to ECHO, told me that they have one hectare of black sapote growing and doing well in the tropical rainforest in Kanana, Congo. The people have enjoyed this introduced fruit and eat it fresh after the fruit has ripened and softened and the inside has turned into a dark brown chocolate color. At first glance, most people would be turned off by the dark mushy flesh, but those who look past the unusual appearance will enjoy a delightful tasting, sweet and nutritious fruit nicknamed "chocolate pudding fruit." Originally from Mexico, the popularity of this fruit is starting to spread outside Central America. Paul Noren says that the Congolese do enjoy this fruit very much but one disadvantage is that it takes 5 to 6 years to bear fruit. The stand of 400 trees started from seeds 17 years ago is now a thick forest and has shaded out all the imperata grass. It has thrived with little cultivation.

The fruit is the size of a tomato, about 10 cm in diameter. The fruit can weigh 200 to 900g and has about 2 to 10 seeds inside, although some trees bear seedless fruit. The fruit has a thin but firm shiny dark green coat with a persistent and large calyx that stays green (Figure 2). When it ripens on the tree or after it is picked, the fruit turns darker green to dull brown. It is ready to eat when it has softened completely (1 to 2 weeks at room temperature); it will feel very mushy. The unripe fruit is very astringent and caustic. Nutritionally, it has a fair amount of vitamin A and potassium, and has four times more vitamin C than an orange (www.daleysfruit.com.au/fruit%20pages/blksapote.htm).

Figure 2: Photo of black sapote fruit, including some that are cut open and ready to eat. Seeds are pictured at the front of the plate. Photo by Oscar Jaitt, Fruit Lover's Nursery. Used with permission.

A handsome evergreen tree, black sapote can grow up to 25 m (80 ft). It grows well in hot lowland tropical climates and enjoys a climate with distinct wet and dry seasons. However, it can grow as high as 1,500 to 1,800m (5,000 to 6,000ft) (Julia Morton, *Fruits of Warm Climates*). In drier areas, it thrives with irrigation. The tree can tolerate a wide range of soils and nutrient conditions. It requires full sun and can tolerate temperatures as high as 42°C and as low as –2°C (28°F). Young trees should be protected from wind and frost. Propagation is usually by cleft grafting or by seeds. Seeds can be stored in cool, dry storage for a few months. The seedlings can be set in the field when they are 1 to 2 years old and should be spaced at least 12m (40 ft) apart. (Morton).

There are many ways to eat this rich, pudding-like fruit. Because it has a mild flavor, it can be added to different fruit drinks. ECHO's executive director's wife likes to add whipped cream to chilled halves of black sapote for a nice dessert. Our interns have made black sapote bread and a pudding made with mashed black sapote, whipped cream, sugar and cocoa. Our farm manager likes to make a breakfast porridge with the pulp, raw oats, peanut butter, powdered milk and honey. There are many recipes for black sapote pie, mousse, cake, and Dulce de Sapote Negro. In the Philippines, the pulp is served with milk or orange juice poured over it.

Check ECHO's website (www.echotech.org) for links to recipes that use black sapote.

We will have seeds available in the late fall (November). Those working in agricultural development in developing countries may request one free sample packet of black sapote seed, to be shipped next season. All others may purchase the seed from ECHO. The overseas price is $4.50/packet and the domestic price is $4.00/packet.

THIS ISSUE is copyrighted 2005. Subscriptions are $10 per year ($5 for students). Persons working with small-scale farmers or urban gardeners in the third world should request an application for a free subscription. Issues #1-51 (revised) are available in book form as *Amaranth to Zai Holes: Ideas for Growing Food under Difficult Conditions*. Cost is US$29.95 plus postage in North America. There is a discount for missionaries and development workers in developing countries (in North America, US$25 includes airmail; elsewhere $25 includes surface mail and $35 includes air mail). The book and all subsequent issues are available on CD-ROM for $19.95 (includes airmail postage). Issues 52-88 can be purchased for US$12, plus $3 for postage in the USA and Canada, or $10 for airmail postage overseas. ECHO is a non-profit, Christian organization that helps you help the poor in the third world to grow food.