ECHO® Development Notes

Edited by Dawn Berkelaar and Tim Motis | October 2017 | Issue 137

Insects for Food and Feed

by Dawn Berkelaar

INTRODUCTION

Insects are an often-overlooked food and feed source. In many areas of the world, they have been eaten for centuries. In 1885, Vincent M. Holt wrote a document called "Why Not Eat Insects?" in which he described historical instances of people who ate insects and considered them a great delicacy. Worldwide, more than 1900 insect species have been used as food (van Huis *et al.* 2013). Of these, beetles (mostly larvae) make up 31%; caterpillars of butterflies and moths make up 18%; larvae and pupae of bees, wasps, and ants make up 14%; and grasshoppers, locusts and crickets make up 13% (van Huis *et al.* 2013).

Where insects are not typically viewed as a food source, people often have an internal aversion to eating them. Even so, we all do eat insects, though often unknowingly. Insects are found in small amounts in dry goods like beans and grains, and in food products such as peanut butter. In the USA, the FDA allows a certain number of insect parts in various commodities--for example, peanut butter is allowed an "average of 30 or more insect fragments per 100 grams." In this case, legislation exists to limit the number of insect parts.

What about eating insects on purpose? Insects make sense as a food and feed source for many reasons. First, there is huge precedence already. Insects have been eaten for thousands of years (examples are given by Holt 1885), and more than two billion people currently incorporate insects into their diets (van Huis *et al.* 2013; Figure 1).

Second, insects are very nutritious—high in protein, fat, fiber, vitamins and minerals. Nutrient content of insects varies between species and within a species depending on metamorphic stage; it also depends on what insects are fed. But Rumpold and Schlüter (2013) compiled nutritional information for many species of edible insects and concluded, "Although the data were subject to a large variation, it could be concluded that many edible insects provide satisfactorily with energy and protein, meet amino acid

Figure 1. Edible insect buffet in Chiang Mai. *Source: Rick Burnette*

requirements for humans, are high in MUFA [monounsaturated fatty acids] and/or PUFA [polyunsaturated fatty acids], and rich in several micronutrients such as copper, iron, magnesium, manganese, phosphorous, selenium, and zinc as well as riboflavin, pantothenic acid, biotin, and in some cases folic acid." According to Yhoung-Aree *et al.* (1997), the protein content of insects ranges from 7 to 21 grams per 100 grams edible portion. This compares well to that of eggs (14 g/100 g; approximately two large eggs) or meat (18-20 g/100 g). Insects are nutritious enough that a team of researchers in Kenya is using grasshoppers and locusts, ground together with malted finger millet, to produce nutritious baby food that will combat malnutrition (Oniang'o 2017).

Third, eating insects makes sense from an environmental point of view. Insects have a high feed conversion efficiency, meaning that a high proportion of the feed and water they are fed is converted into edible matter. According to Marcel Dicke (2010), 10 kg of feed translates to 9 kg of harvestable locusts. By contrast, feed conversion efficiencies for animals range from 5 kg edible matter per 10 kg feed (chickens) to 1 kg edible matter per 10 kg feed (cows). An FAO web page shares slightly different but still encouraging statistics: "Insects have a high food conversion rate, e.g. crickets need six times less feed than cattle, four times less than sheep, and twice less than pigs and broiler chickens to produce the same amount of protein. Besides, they emit fewer greenhouse gases and less ammonia than conventional livestock. Insects can be grown on organic waste. Therefore, insects are a potential source for conventional production (mini-livestock) of protein, either for direct human consumption or indirectly in recomposed foods (with extracted protein from insects); and as a protein source into feedstock mixtures."

It is best not to assume that such high efficiency is possible in every case. In an article titled "Crickets are not a free lunch," authors Lundy and Parrella (2015) point out that crickets' growth and even viability depends on the quality of their diet, especially at an industrial scale. Still, a company called Agriprotein, raising black soldier fly larvae as a protein source for animal food, harvests six and a half tons of

Featured in this EDN

Honoring God by empowering the undernourished with sustainable hunger solutions.

ECHO
17391 Durrance Road
North Fort Myers, FL 33917 USA
p: 239-543-3246 | f: 239-543-5317
www.ECHOcommunity.org

MagMeal (ground and dried larvae) from 100 tons of organic waste (Thomas 2017a). Considering that the six and a half tons are dry weight and that the company sources the organic food waste for free, it is a pretty good ratio.

Fourth, insects need very little space, so they can be raised even by those with little access to land. Many insects thrive in close quarters. And finally, raising insects has potential to be an income-generating endeavor (Figure 2).

This article will give a brief overview of insects for food and for feed. It will describe ways to obtain and prepare insects, and will outline some of the challenges that exist when it comes to eating insects.

INSECTS FOR FOOD

Insects are an excellent food source for humans, as previously mentioned. However, most people in Western countries are unused to eating insects. Because of their internal aversion to it, eating insects is sometimes communicated or viewed as a disgusting practice or “last resort.”

Even the terminology we use affects the impression we give about the desirability of eating insects. "Entomophagy" is the term most commonly used for the practice of eating insects. Evans *et al.* (2015) explain why this is problematic. They point out, for example, that other terms ending in “phagy” refer to animal-like, “inappropriate or even pathological behaviors” (e.g. hyalophagy—eating glass).

Figure 2. Honeycomb and honey bee pupae for sale in Myanmar. *Source: Rick Burnette*

Also, the term "insects" is used to mean different things. It has a taxonomical definition (see the text box), but people sometimes also use it—or the term "bugs"—to refer to other small, edible creatures, including spiders, scorpions, centipedes, and earthworms. Some people only use the term "insects" to refer to pest species; for this reason, it can be helpful to distinguish between "insects" and "edible insects."

Evans *et al.* (2015) point out that “food taboos are complicated.” People groups have their own preferences and aversions to different kinds of insects. "Insect" is a general category, but in order for insects to be embraced as food, people need familiarity with specific types of insects. Instead of speaking of the broad category of "insects," it can be helpful to speak of individual species and preparations. For example, try to use names from the local culture where possible (e.g. grasshoppers called chapulines in Mexico). Alternatively, rename insects to make them sound more appealing; for example, Marcel Dicke has referred to grasshoppers as “land shrimp” (Dicke 2010).

An overview of some traditionally eaten insects around the world can be found on pages 15 to 20 of the FAO document “Edible Insects: Future prospects for food and feed security" (Van Huis *et al.* 2013).

Insects - A Primer

Insects belong to Class Insecta within Phylum Arthropoda. Within Class Insecta, they are further broken down into Orders.

An insect experiences several different stages during its (usually) brief life. Some insects—including butterflies, bees, and beetles—undergo **complete metamorphosis**, so that the young look completely different from the adult. In this case, an insect begins its life in an *egg*. It hatches into a *larva*, typically resembling a short fat worm. It turns into a *pupa*, during which time it is immobile and enclosed in a case, before finally emerging as an *adult*. Insects can be eaten at any stage, but some tend to be preferred in certain stages over others.

Insects like grasshoppers and cicadas undergo **incomplete metamorphosis**. In this case, the insect hatches out of its *egg* into a *nymph*. The nymph sheds its skin as it grows. The nymph looks much like the *adult*, but often does not have wings until the final transition to an adult.

INSECTS FOR FEED

Insects can be an excellent protein source for animal feed. They need no processing to be fed to chickens or to fish; free-range chickens peck and eat insects naturally. Meal made from insects can be used in feed rations for pigs and cows, replacing expensive protein-rich ingredients such as fishmeal or soybean. In a podcast episode, Elsje Pieterse from the University of Stellenbosch explained why soy and fishmeal are problematic. Production of soy is linked with deforestation and loss of plant diversity, while fishmeal is made from small fish that are important in oceanic food chains and are in danger of being overharvested (Thomas 2017b).

Larvae of the black solder fly (*Hermetia illucens*) are a popular protein source for animal feed. Ian Banks, working in research and development with Agriprotein, shared several characteristics that make black soldier fly larvae good candidates for mass-rearing (Thomas 2017a). The larvae are omnivorous, able to eat both meat and vegetable waste. They also grow quickly, reaching 2 cm in less than two weeks, and have less of a “disgust factor” than do the maggots of houseflies. Adult flies do not spread disease like houseflies do.

As mentioned in the introduction to this article, BSF larvae are being farmed on an industrial scale, by Agriprotein and other companies. Two episodes of the BBC Food Chain podcast (hosted by E. Thomas) describe Agriprotein’s basic farming process. The BSF larvae are fed food waste such as vegetable and fruit peelings. Once the larvae consume the food waste, the residue can be used as compost. For their part, the larvae in the form of MagMeal are an excellent source of protein for animal feed. Nutrition Hub, a consultant company running tests at the University of Stellenbosch, has compared the health and growth performance of fish that are fed fishmeal and fish that are fed a mixture of fishmeal and MagMeal. When up to 50% of fishmeal in their feed was replaced with MagMeal, farmed trout experienced no negative effects on growth (though growth was reduced with 100% replacement of fishmeal) (Thomas 2017b).

Figure 3. Palm weevil pupae in a market in Myanmar. *Source: Rick Burnette*

Though larvae at Agriprotein are fed on fruit and vegetable waste, BSF larvae have also been found to grow well on pig liver, and pig manure (Nguyen *et al.* 2015). Still, food waste is the most logical thing to feed to black soldier fly larvae. Jason Drew, cofounder of Agriprotein, commented that where there are people, there is food waste. His company is expanding to a number of other countries. In a podcast interview, he stated, "We have many more customers than we could ever supply." (Thomas 2017b).

Information on smaller-scale methods for rearing black soldier fly larvae can be found online, for example at the Black Soldier Fly Farming website and at Black Soldier Fly Blog.

Black soldier fly and several other insects have their own section on the Feedipedia website (an "animal feed resources information system").

Research on the use of insects for feed is also being led by ICIPE (The International Centre of Insect Physiology and Ecology. Programs by ICIPE include INSFEED ("Insect feed for poultry and fish production in sub Saharan Africa"); GREEiNSECT ("Mass-rearing insects for greener protein supply") and ILIPA ("Improving livelihood by increasing livestock production in Africa"; this one is focussed mainly on the black soldier fly). Some of the work being done in Kenya through this program is described in an article in *Spore* Issue 184: "…the INSFEED project has trained more than 75 farmers and young agripreneurs in insect mass rearing using sustainable, accessible and cost-effective techniques, such as harvesting the locally abundant blue Calliphora fly."

WAYS TO OBTAIN INSECTS

Insects are typically obtained in three main ways.

First, they can be wild-caught. Sometimes traps are set up overnight, to be checked in the morning. Alternatively, insects can be collected in the early morning, when temperatures tend to be cool and insects are sluggish and slow. At certain times of year, insects are plentiful and easy to catch. This is true, for example, where the winged reproductives of termites emerge en masse once a year in parts of Africa, or when flying ants called "chicatanas" swarm through the air in Mexico. But be careful--if insects have been in or near farmers' fields, they may have been sprayed with insecticides!! Even if you do not use chemicals on your farm or project site, do not assume that the insects found there are safe; insects, especially those that fly, may have encountered pesticides elsewhere.

Second, insects can be farmed on a large, industrial scale. This is risky and requires significant investment, but is being done successfully by companies like Agriprotein.

Third, insects can be "farmed" on a small, backyard scale. This can be done with local technology as a low-capital investment. Insects can be grown in a very small space with few resources; however, raising them requires a relatively high level of knowledge about the species' life cycle, diet and habitat needs. A literature review by Gahukar (2011) includes references to papers that describe rearing techniques for palm weevils (see Figure 3), silkworms (in India and Thailand; see Figure 4), giant hornets (Japan), crickets (Thailand), and more.

Figure 4. Silkworm larvae in India. *Source: Rick Burnette*

Species that people commonly raise themselves include:

Mealworms

A series of videos at www.mealflour.org/diy explains how to make a small three-tiered mealworm farm. Instead of a plastic organizer (as is used in the videos), wooden boxes could be used. The top box houses adult beetles. Mesh in the bottom of the top box (tightly sealed where the mesh joins the box) allows eggs to fall through to the next level. Small worms are transferred to the bottom box. They are harvested when they reach a certain size (Figure 5), or else allowed to pupate and placed in the top box to continue the cycle. Instructions for raising mealworms are also found in the *Food Insects Newsletter,* Volume 9 Issue 1. Mealworms would need to be found or bought initially. Check if they can be ordered online, or check at a local pet supply store.

Figure 5. Mealworms raw (top) and fried (bottom). *Source: Stacy Reader*

Crickets

An article from *Popular Science* describes a basic way to raise crickets. Another helpful document is at this site from the FAO. To obtain crickets initially, ask around if people are already raising them and might sell you some, or buy some at a pet store.

Black Soldier Flies

Sources of information for raising black soldier flies were shared in the section on insects for feed. BSF in the larval stage are sometimes referred to as "latrine larvae," since they are often found around manure piles (van Huis *et al.* 2013)—so they could potentially be sourced that way if not available commercially.

Table 1: Some commonly eaten insects. Compiled by Dawn Berkelaar from Gahukar 2011; van Huis *et al.* 2013; Holt 1885; and Yhoung-Aree *et al.* 1997.

Type of Insect	Stage	Collection Method	Preparation	Notes
Coleoptera (Beetles)	Grubs (e.g. palm weevil; *Rhynchophorus* spp. See Figure 3)	Detected with an ear to a palm tree, to listen for nibbling larvae	Fried or roasted	Palm weevils are consumed in Asia, Africa and Latin America. Be careful not to fell too many trees, for long-term sustainability.
	Adults (e.g. dung beetles)	*	Left for 24 hours to excrete waste, then washed well and cooked.	
	Larvae (e.g. mealworms. See Figure 5)	*	Fried or roasted	
Hemiptera ("true bugs," with mouthparts for piercing and sucking)	Adult (e.g. cicadas)	*	Wings removed; roasted over open fire or stir-fried without oil	
Hymenoptera (Bees, wasps, ants)	Larvae and pupae of bees and wasps (see Figure 2)	Colony is smoked to drive off adults; larvae and pupae are collected	Roasted; stir-fried; boiled with porridge or rice. Often smoked in the process of collection, so sold ready-to-eat	
	Eggs (ants; see Figure 6)	*	Eaten raw or fried	
	Pupae (ants)	*	In Thailand, the pupae of weaver ants are eaten raw in certain salad-like dishes.	
	Adults (ants)	*	Used for flavouring because they contain formic acid	
Isoptera (termites)	Winged adult reproductive	Collected with nets, baskets, etc. when they emerge after first rains	Eaten raw; lightly fried or roasted; sundried. No oil needed.	Especially rich in protein, fatty acids, and other nutrients. Termites can also be fed to pigs, poultry and fish.
	Soldiers	Collected any time of year	Eaten raw; lightly fried or roasted; sundried. No oil needed.	
	Queen	*	*	The queen can be up to 10 cm in diameter! Considered a delicacy, but harvesting a queen will kill the termite colony.
Lepidoptera (butterflies, moths)	Caterpillars (e.g. mopane)	Collected, degutted	Degutted, boiled in salt water and sun-dried	Important source of protein during the rainy season.
	Pupae (e.g. silkworm)	Remain when silk is removed from cocoons	Roasted; or fried in butter or lard, then seasoned with pepper, salt and vinegar	
	Caterpillar (e.g. bamboo)	*	Deep-fried	
	Adult moths	*	Fried in butter	
Odonata (dragonflies, damselflies)	Nymphs (immature stage)	Collected from water	Stir-fried or boiled	
Orthoptera (grasshoppers, crickets, locusts)	Adults	Collected in early morning and evening, when gathered and inactive	Legs, wings, head and stomach often removed. Stir-fried; deep-fried; roasted; or boiled and then fried in butter. Sometimes these are smoke-dried in bamboo pipe.	Around 80 species of grasshopper are consumed. Two species of crickets are farmed in Asia. Locusts and grasshoppers for food are mentioned at least twice in the Bible, in Leviticus 11:20-23 and Matthew 3: 1, 4.

* An asterisk in the table indicates a lack of information. Please share your own knowledge and experience when it comes to collecting, preparing, and eating insects!

Preparing Insects

Though some are eaten raw, most insects used for food are cooked and/or dried. Insects can be sautéed with garlic and salt, baked or roasted in an oiled pan until golden and crispy, or battered and fried. Roasted crickets or mealworms are sometimes ground, then added to sauces or baked goods. Table 1 lists a few relatively common edible insects, with some information about collecting and preparing them. But the table only names a few of the many insects that are edible; Mr. Yde Jongema has compiled an extensive list of edible insects of the world, available online. As a general rule of thumb, Holt recommended collecting insects that eat non-poisonous plants, and avoiding insects that are carnivorous and/or eat poisonous plants.

Yhoung-Aree *et al.* (1997) described when and how various insects are collected and eaten in Thailand, including details about specific preparation methods. They comment that in rural communities in Thailand, insects are often cooked as main dishes, eaten with rice; in urban areas, where insect-eating is less common, insects are eaten more as snack foods.

CHALLENGES

In a TEDx talk, Arnold van Huis shared his excitement over the potential of insects for food but also pointed out some challenges. For example, little legislation exists around insects. Though most insects are safe to eat, pesticides can be a concern with wild-caught insects. Also, for insects raised specifically for food, one hopes for at least a base level of sanitation and standards, but no official rules or guidelines currently exist.

In an NPR interview, Robert Allen described the advocacy role of his organization (educational non-profit Little Herds) as, "pushing both businesses and regulatory agencies to adhere to the highest standards when creating the rules and laws of this new sector." He added, "We believe insects can and should be raised and harvested hygienically, organically, antibiotic and hormone free, humanely and at least in part locally. If we set the bar high now, we don't risk following in the footsteps of the factory farming that we now realize has serious negative side effects."

Food safety is not the only concern. When it comes to harvesting insects in the wild, forest management and insect conservation

Figure 6. Ant eggs and larvae. *Source: Rick Burnette*

are linked. Measures to preserve edible insects must include efforts to maintain forest cover and manage host plants of edible insects. This may require community efforts and also government incentives for conservation (Gahukar 2011).

Potential economic development is also a consideration, and one that can be at odds with regulations. Government involvement in setting regulations is important in multiple sectors, including food safety and conservation. However, Halloran *et al.* (2015) point out that, "Formalization through regulation can threaten local, informal economy. On the other hand, informal economy provides employment and income, especially in areas of high unemployment."

Some existing regulations limit the use of insects for food and feed. In the European Union, regulations on animal feed ingredients (because of concerns related to bovine spongiform encephalopathy (BSE), also known as "mad cow disease") have prohibited the use of animal protein, including insect protein (Stout, 2016). However, in the summer of 2017, the European Commission relaxed its rules on insect protein, approving it for use in aquaculture (Thomas 2017b).

Cost can be a challenge for those looking to purchase insects. In most places, farm-raised insects are not very common, especially insects raised for food, and their price may reflect that. Where I live in Canada, two small 227 g bags of insects, one of crickets and one of mealworms, would have cost me $60 with shipping. By contrast, 454 g of ground beef at a local grocery store would cost around $5. Cost is less of an issue if you raise your own insects in a small-scale, locally appropriate backyard situation.

Another concern is that individuals who are allergic to or react to shellfish might also be allergic to insects, because of shared allergenic substances including a protein called tropomyosin (Palmer 2016). Rumpold and Schlüter (2013) commented, "Liabilities of entomophagy include the possible content of allergenic and toxic substances as well as antinutrients and the presence of pathogens." Allergies can also develop with exposure; Phillips and Burkholder (1995) commented that "[contact with] insects and related arthropods pose a very real occupational health threat to workers repeatedly exposed to them." Health concerns are summarized in an issue of *The Food Insects Newsletter*.

CONCLUSION

Insects have tremendous potential as a food and feed source. Small-scale farmers can collect insects in the wild, or raise them inexpensively on-site with local technology. Insects are incredibly diverse and can be a delicious way to improve nutrition. Are insects currently eaten and enjoyed in your community? If you have experience using insects for food and/or feed, we would love to hear from you!

REFERENCES

Dicke, M. 2010. Why not eat insects? TED Talk.

Evans, J., M.H. Alemu, R. Flore, M.B. Frøst, A. Halloran, A.B. Jensen, G. Maciel-Vergara, V.B. Meyer-Rochow, C. Münke-Svendsen, S.B. Olsen, C. Payne, N. Roos, P. Rozin, H.S.G. Tan, A. van Huis, P. Vantomme and J. Eilenberg. 2015. 'Entomophagy': an evolving terminology in need of review. *Journal of Insects as Food and Feed* 1(4): 293-305. Wageningen Academic Publishers.

Van Huis, A., J. Van Itterbeeck, H. Klunder, E. Mertens, A. Halloran, G. Muir and P. Vantomme. 2013. Edible insects: Future prospects for food and feed security. FAO Forestry Paper 171.

Gahukar, R.T. 2011. Entomophagy and human food security. *International Journal of Tropical Insect Science* 31(3):129-144.

Halloran, A., Vantomme, P., Hanboonsong, Y., and Ekesi, S., 2015. Regulating edible insects: the challenge of addressing food security, nature conservation, and the erosion of traditional food culture. *Food Security* 7: 739-746.

Holt, V.M. 1885. Why Not Eat Insects?

Lundy M.E. and M.P. Parrella. 2015. Crickets Are Not a Free Lunch: Protein Capture from Scalable Organic Side-Streams via High-Density Populations of *Acheta domesticus*. *PLoS ONE* 10(4): e0118785. doi:10.1371/journal.pone.0118785

Nguyen, T.T.X., J.K. Tomberlin, and S. Vanlaerhoven. 2015. Ability of Black Soldier Fly (Diptera: Stratiomyidae) Larvae to Recycle Food Waste. *Environmental Entomology* 44(2): 406-410.

Oniang'o, M. 2017. Grasshoppers and locusts for protein-rich baby food? Africa.com; also republished on Agrilinks.org.

Palmer, L. 2016. Edible insects as a source of food allergens. M.Sc. thesis, University of Nebraska.

Phillips, J. and W. Burkholder. 1995. Allergies Related to Food Insect Production and Consumption. *The Food Insects Newsletter*. Volume 8, Issue 2. USDA-ARS Stored Product Insects Research Laboratory. Department of Entomology. University of Wisconsin-Madison.

Reeve, S. 2017. Nutrient rich fish and poultry feed. *Spore* 184.

Rumpold, B.A. and O.K. Schlüter. 2013. Nutritional composition and safety aspects of edible insects. *Molecular Nutrition & Food Research* 57(5):802–823.

Stout, J. 2016. Insects as food is one thing—but how about insects as feed? Blog post on www.bugsfeed.com.

Thomas, E. 2017a. Maggot Masters. *The Food Chain Podcast*. BBC World Service. September 20, 2017.

Thomas, E. 2017b. A Fly Future? *The Food Chain Podcast*. BBC World Service. September 27, 2017

Yhoung-Aree, J., P. Puwastien and G.A. Attig. 1997. Edible insects in Thailand: an unconventional protein source? *Ecology of Food and Nutrition* 36:133-149.

Other Resources

Bugs Documentary

This looks like a fabulous documentary! Unfortunately, it was not available for viewing in North America when I was working on this article. In a review of the documentary, Barbara King wrote:

"Chef Ben Reade and food researcher Josh Evans of the Nordic Food Lab in Copenhagen travel the world, from Uganda to Italy and Japan to Australia, sampling local insects. They become excited (ecstatic, even) over the array of delicious protein choices out there, ranging from roasted termite queens to the honey of stingless bees.

"But they also push back hard against any simple notion that "insects can save the world." They become especially jaded by schemes to turn insect products into food brands that will mostly serve to line the pockets of big corporations. For Reade and Evans, the key to environmentally healthy eating isn't mass-produced insects; it's diversity in growing and eating good, locally sustainable foods."

More on BSF for animal feed

This links to a short video about another company raising black soldier fly larvae, with footage of the flies, larvae, and resulting meal.

. . . . .

Resilient Bamboo

by Gene Fifer

In September, ECHO's Global Farm in Florida faced a fairly direct hit by Hurricane Irma. In the aftermath, one thing is abundantly clear – some things fall down and some things don't (see our short video, After Hurricane Irma). This fact is relevant to our efforts to promote resilient farms and landscapes. Natural disasters come in many forms and often wreak havoc due to flooding, rain, landslides, and building collapse. When recovering from natural disasters, one important step is to evaluate, remember, and promote the plants and structures that were most resilient.

Bamboo plays many important roles in tropical landscapes. It can stabilize hillsides during monsoon rains, act as a windbreak for buildings and crops, and produce strong, flexible building material that strengthens homes during high winds and earthquakes. These ecosystem services and structural qualities are well known in places like the Philippines where cyclones and earthquakes are common. ECHO's demonstration farm in southwest Florida grows many species of bamboo. Factors that contribute to the ability of bamboo to withstand strong winds are a well-developed root system, flexibility of the canes, and narrow leaves (varieties with large, wide leaves intercept more wind than those with smaller leaf blades; Figure 7).

We recommend two excellent resources about bamboo and bamboo construction. The first is the Bamboo Construction Source Book by the Community Architects Network (2013). This free, downloadable 100-page treatise has chapters on bamboo as a plant; bamboo as a construction material; and bamboo's role in building systems. The document contains excellent photographs and illustrations that demonstrate joinery, lashings, and both traditional and modern techniques. [NOTE: An ECHO Technical Note, currently in progress, will explain bamboo treatment and construction methods used by our Appropriate Technologies department.] The second resource is the website Guadua Bamboo. This site, from a for-profit company based in Latin America, has excellent pages on bamboo species, cultivation, and construction in English. The site also provides a wealth of information in the form of free, downloadable PDF publications.

Figure 7. Large leaves of *Dendrocalamus minor* 'Amonenus' (left) versus smaller leaves of *Bambusa malangensis* (right) Most of the bamboo uprooted by Hurricane Irma, on ECHO's Global Demonstration Farm in Florida, were *Dendrocalamus minor*. *Source: Tim Motis*

We welcome further information about bamboo's usefulness. Please share with us published resources and personal stories that emphasize various species' ability to hold soil, stabilize hills, and act as windbreaks. Every disaster affords us the opportunity to learn and share. Help us grow from the challenges before us.

. . . . . .

Invitation to LEAD Asia Web-Based Talk

by Rebecca Garofano

Over recent years, greater attention has been given to critical links between agriculture and nutrition. Are you interested in learning and discussing ways to leverage agriculture practices – whether for home gardens, production fields, or agroforestry plots – to consider the nutritional and health needs of the community in which you work? You don't have to be an expert on nutrition to understand the importance of nutrition to well-being in the community. If you are focused on education, a great deal of research shows strong links between adequate nutrition and positive learning outcomes for children.

LEAD Asia is pleased to have Cecilia Gonzalez, ECHO's very own Team Leader for the Latin America/Caribbean Impact Team, share her experiences with nutrition and community development during our November "Transformational Development Forum" online call. Cecilia has extensive international experience. While pursuing her graduate studies at Cornell University, she focused on international development and conducted research on iron nutrition.

This topic is part of a series of web-based talks that gather development practitioners from different organizations working with communities around the world, to discuss important topics. The talk will be given twice, on November 8th and 10th, to cater to a global audience. To learn more about this topic and to sign up for the call, visit our schedule and information link and follow prompts.

ECHOES FROM OUR NETWORK

Living Fence Advice

The following question was asked at ECHOcommunity Conversations (ECHO's new forum):

> *"I'm looking for recommendations for a certain type of crop that might allow me to keep livestock out, but would not overrun crops near it. Anybody have some suggestions?"*

Network member Roy Danforth shared his recommendations and experience in Central Africa. Please share your own experiences, ask questions and connect with others through ECHOcommunity Conversations at https://conversations.echocommunity.org/.

Here in Central Africa, rains are frequent and termites are in abundance, so cutting down trees for stick fences is simply not practical - they last only a few months. At the CEFA experimental and training farm, we have researched several types of "living fences" and we have come up with this winner.

Along the border of your property or garden, dig a one meter wide and one meter deep trench as your first deterrent. Pile all the dirt from the trench on the inside of your garden or property, making a triangular hill that slants into the trench - this is the second barrier of sorts.

Next, on the slanted side of the hill facing the trench, plant sisal plants, sometimes known as century cactus - the type that has nasty thorns on the leaf edges and tips. There are different varieties, but the large size is recommended; plant them 1 to 2 m from each other in a single row or in two rows, but staggered. This is your third and main part of the living fence.

Fourthly, plant vetiver grass, a very deep-rooted erosion-control grass along the opposite edge of the hill, on the outside edge of the trench. Plant the sprigs right next to each other. All of this takes a good year to grow and fill in, keeping cows, pigs, goats, and even people from entering your property or garden.

One other option is to add thorny shrubs in between the sisal as a fifth barrier. If you absolutely need the fence now, you can add a sixth obstruction of one-meter-high glyricidia fence, simply by cutting glyricidia sticks and poking them in the ground. They sprout quickly in the rainy season and can be constructed at the top of the hill. If you don't know what sisal or vetiver or gliricidia are, just look them up on the web. Here in Central Africa, the local variety of living fence is the jatropha plant. Cuttings are planted close together and grow quickly.

[See Figure 8 for a diagram of the above explanation.]

You'd be surprised what is available locally - gliricidia was the only plant our program introduced. The others were found in the area.

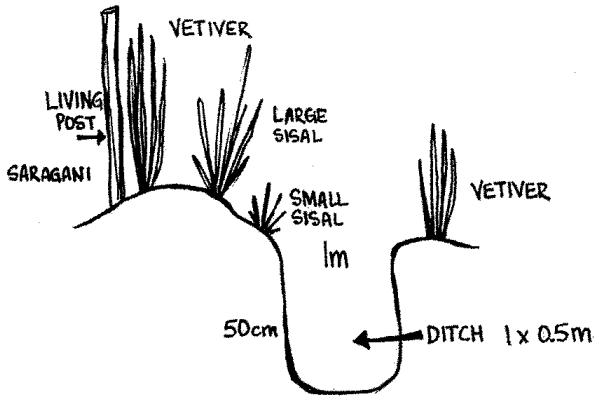


Figure 8. A combo fence of saragani mats, vetiver, sisal, and a ditch. *Source: Agroforestry in the Central African Home Garden; A manual for tree gardening in the humid tropics, Roy Danforth*

FROM ECHO'S SEED BANK

Tamarind: A Tart Addition for the Home Garden

by Gene Fifer

Tamarindus indica, also known as Indian date or tamarind, is a tree with seed pods traditionally used for fruit juice, chutneys, curries, and desserts in South Asia. But it is also a drought resistant source of livestock fodder, firewood, timber, and bee forage, and its lacy canopy (Figure 9) provides medium shade for other crops. Cover crops like cowpea and horse gram can be grown in its shade for erosion and weed control; so can vegetables like tomatoes that are susceptible to sunscald. Tamarind is a low-maintenance tree with no significant pest or disease problems. It grows in a wide range of soil types and between sea level and 1500 m elevation.

Figure 9. Tamarind tree (left), pod and flower (right). *Source: Tim Motis*

Tamarind timber is strong, termite resistant, and prized for furniture. It is especially useful for making mortars, pestles, axles, and other hardwear implements. The wood is good for both fuelwood and charcoal. Its deep root system and strong wood make it resistant to wind damage.

The sticky pulp surrounding the seeds contains 30 to 40% sugar with a high vitamin C content. The pulp is mixed with sugar and water for a refreshing juice and is used medicinally to soothe digestion and as a laxative. The leaves and young seed pods can be eaten as a vegetable in soups and stews. Leaves can also be used to make a red dye for woolens.

Propagation is by seed, trial packets of which are available through the ECHO Online Seed Catalog. Seedlings take 6-12 years to mature and bear fruit. Mature trees can live as long as 200 years.

Further Reading:

Ecocrop

Fruits of Warm Climates

Missouri Botanical Garden

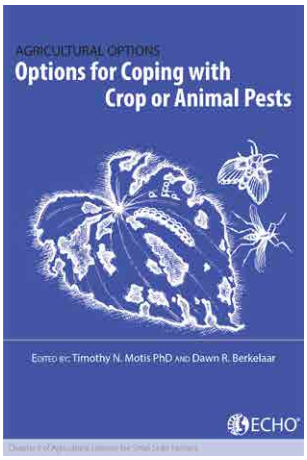
Permaculture Research Institute

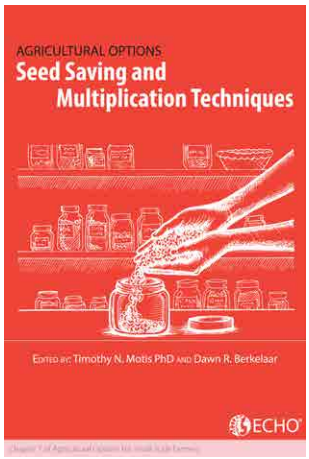
BOOKS, WEB SITES AND OTHER RESOURCES

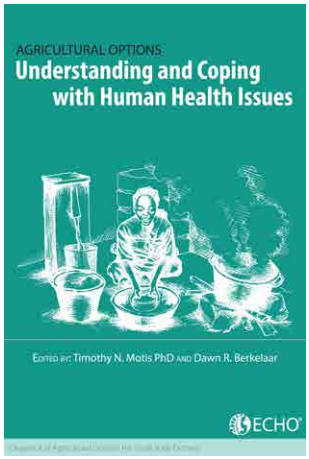
New epublication Releases: Options for Coping with Crop or Animal Pests, Seed Saving and Multiplication Techniques, and Understanding and Coping with Human Health Issues

ECHO is pleased to announce availability of the ebooks ***Options for Coping with Crop or Animal Pests***; ***Seed Saving and Multiplication Techniques***; and ***Understanding and Coping with Human Health Issues***. These electronic publications include the content from the sixth, seventh and eighth chapters of *Agricultural Options for Small-Scale Farmers: A Handbook for Those Who Serve Them* (originally published in 2012 as a sequel to *Amaranth to Zai Holes*).

Options for Coping with Crop or Animal Pests explains ways to minimize crop damage caused by animals, insects and plant diseases. The book shares helpful repellent recipes, control methods and other strategies for managing crop health.







Seed Saving and Multiplication Techniques provides an overview of the vital role of seed systems in agriculture, from seed multiplication in the field to seed acquisition and distribution. Principles and best practices for seed saving are also detailed in this book.

Understanding and Coping with Human Health Issues helps the reader comprehend various human health issues that are a daily concern, specifically in the Global South. It offers options to improve plant nutrition; minimize plant toxins; reduce smoke from cooking fires; clean contaminated drinking water; and prevent/treat malaria.

Each of these ebooks is available for purchase from Amazon in English, Spanish and French, for $4.99 per book.

We hope that the perspective found in these ebooks will help improve the livelihoods of smallholder farmers around the world. Please let us know how their content contributes to your efforts to serve those in your community.

UPCOMING EVENTS

ECHO Florida Events:
Location: ECHO Global Farm, USA
Presented by: ECHO

Tropical Agriculture Development: The Basics
January 15-19, 2018

Tropical Agriculture Development: The Basics
July 23-27, 2018

Introduction to underutilized and tropical crops: Growing, harvesting, preparation
September 10-14, 2018

Introduction to Permaculture
April 30 - May 4, 2018

Tropical Agriculture Development: 101 (geared towards University students)
- email rgill@echonet.org for more information

ECHO Asia Event:

2018 Asia Pacific Sustainable Agriculture & Development Conference
February 6-9, 2018
Location: Asia Pacific Theological Seminary (APTS), Philippines
Presented by: Samaritan's Purse Canada, ECHO Asia, and The SEED Project

ECHO East Africa Events:

Strong Harvest Moringa Peer Educator Training Seminar
November 3-4, 2017 (English)
November 6-7, 2017 (Swahili)
Location: ECHO East Africa Impact Center
Presented by: Strong Harvest

Best Practices in Pastoralist Areas
March 6-8, 2018
Location: Sportsman's Arms Hotel, Nanyuki, Kenya

Please watch ECHOcommunity for further information. More information and registration details can be found on www.ECHOcommunity.org.

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