ECHO® Development Notes

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# Bringing Back the Pollinators

*by Dawn Berkelaar*

Worldwide, the number of insect pollinators has declined sharply in recent years. Beekeepers have experienced heavy loss of honey bee colonies; in the United States, the number of managed colonies is half of what it was sixty or seventy years ago (USDA; www.tinyurl.com/ooukvz7). The number of wild pollinators has also fallen. In China, insect pollinators are so scarce that apple blossoms must be pollinated by hand, using brushes! (Goulson, 2012 in Chinadialogue; www.tinyurl.com/ps4cvou) Though numbers are difficult to quantify, Dr. Baldwyn Torto at ICIPE (African Insect Science for Food and Health, previously the International Center for Insect Physiology and Ecology) has also commented on a decline in the number of bees in East Africa. He pointed out that Kenya, formerly a producer of indigenous honey, now imports honey (Coordination Team, 2013).

***Figure 1.*** *Bees and other pollinators increase the diversity, abundance and quality of food crops. Photo by Tim Motis.*

Insects pollinate three quarters of flowering plant species—and more than half of human food crops—so this decline in insect pollinators is a sobering reality. Pollinators affect the diversity, abundance and quality of food crops (FAO, 2008).

## Honey Bees

Honey bees (Fig. 1) tend to have the biggest profile as pollinators. In a TED talk titled "Why Bees are Disappearing," Dr. Marla Spivak highlights a number of interacting reasons for the precipitous decline in numbers of honey bees:

Vast fields planted with a single crop are called **monocultures**. Bees in a monoculture field lack variety in their diet, which is problematic even if the monoculture crop is one that is good for bees. Aside from the short window of time that the monoculture crop is flowering, bees find no nectar or pollen in the vicinity, making it essentially a **flowerless landscape**—a desert—for most of the year. However, monocultures present a feast for plant-eating pests, often resulting in the heavy use of **pesticides** by farmers. In much the same way that our own immune systems would be weakened by eating only one kind of food and by exposure to harmful chemicals, bees in this kind of environment become more susceptible to **diseases and parasites**.

What can we do? Spivak encourages a two-pronged approach that will benefit honey bees but also other pollinators: avoid pesticide contamination and plant bee-friendly flowers.

## Avoid Pesticide Contamination

Pesticides' impact on insect pollinators is multifaceted. Herbicides often destroy plants that are important sources of nectar and pollen for pollinators. Insecticides can expose bees, and other pollinators, to toxins in various ways. Direct exposure occurs when toxins are absorbed through the exoskeleton or ingested in nectar. Indirect exposure occurs as contaminated pollen and/or nectar is brought back to the nest. Bees may be killed on contact with insecticides, but exposure to toxins can also disrupt the ability of bees to navigate, and/or render them unable to fly.

Reducing pesticide contamination is an important action to take on behalf of pollinators. "Pesticide Considerations for Native Bees in Agroforestry," a publication by the USDA National Agroforestry Center, shares helpful considerations and suggestions regarding pesticides and native bees, summarized in the following section.

**Non-chemical methods of pest reduction.** Agroforestry practices such as windbreaks, hedgerows and alley cropping can reduce the effects of pesticides, or need for pesticides, in a number of ways. They can reduce pesticide drift (either onto or off of a farm). If windbreaks and hedgerows are kept pesticide-free, they can provide a refuge for pollinators while crops are being sprayed. They can also provide nesting sites and food for insects that prey on or parasitize pest insects.

## Featured in this EDN



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[Other creative and cost-effective alternatives to pesticides have been studied and implemented. For example, stemborers in eastern and southern Africa have been controlled using the 'push-pull' system designed by ICIPE. This system utilizes 1) trap crops, planted around the perimeter of a field, to 'pull' stemborers away, and 2) repellent plants, intercropped in the field, to 'push' the pests away. See *EDN* 77 and *EDN 116* for more details.

In other cases, manually removing larval insect pests from plants makes economic sense, as has been found with pod borer larvae on pigeon peas in India (see *EDN 84-4*).]

**Least-toxic chemical approaches.** Clearly, the best option for encouraging pollinators is to not use any pesticides at all on crops. However, it may be unrealistic to completely avoid the use of pesticides. In situations where pest control is needed, look for the least-toxic approach. The U.S.-based National Sustainable Agriculture Information Service (ATTRA) has an online Ecological Pest Management Database that can help users find "biorational" pesticides, which specifically target a particular insect, and/or break down to become non-toxic. The database can be searched by pest type, pest name, pesticide trade name, and active ingredient/beneficial organism. You can find the database at https://attra.ncat.org/attra-pub/biorationals/.

At ECHO's farm in southwest Florida, we use "soft" chemical controls whenever possible. Andy Cotarelo, ECHO farm manager, defines "soft" chemicals as ones that are pest target specific, are non-persistent (readily metabolized in the soil) and have a low toxicity for the applicator and for non-target organisms. He commented, "Even with the use of "soft" chemical controls, we limit their use to times when the population threshold of pests rises to the point that it becomes necessary. We do not spray for insect pests preventively, but in reaction to the population levels. We do this by surgically spraying for pests instead of blanket applications. We do not spray restricted use pesticides on the farm except in rare cases to knock out a critical pest, especially on plants intended for seed production." One example of such a critical pest is white fly on tomatoes; sometimes a stronger pesticide is used on the farm so that Tomato Yellow Leaf Curl Virus (TYLCV) is not spread by the flies early in the season.

Andy added, "Most of the harder chemistry is limited to perennials because of the benefit received from the labor of spraying." When it comes to diseases (in contrast to pests), he said, "You have to foresee the conditions that will promote the growth of disease and spray preventively. If you spray after the plant is infected or when you see the disease, most of the time you are mitigating the effects of the disease, not curing it. It is very difficult to spray vegetables for a disease curatively."

Some examples of chemicals used regularly on ECHO's farm are commercial neem products, *Bacillus thuringiensis*, soap, oil, garlic and potassium bicarbonate. We use these products in a system in which we employ beneficial organisms, plan crop timing to reduce hosts for pests, and choose varieties that resist pests naturally.

Some pesticides can be made from plants for a less-toxic chemical approach. Homemade neem spray is a common one. Another plant-based pesticide (good for the softer-bodied nymphal stage of many insects) is made from a pinch of cayenne pepper (or ground dried chili with seeds) and one teaspoon of liquid dish detergent in one liter of water. Sometimes a small amount of oil is also added. The mixture is sprayed on the insects. For more ideas of pest control without using purchased pesticides, see Lowell Fuglie's book *Producing Food without Pesticides: Local solutions to crop pest control in West Africa*, reviewed in *EDN* 84-5.

"Pesticide Considerations for Native Bees in Agroforestry" (Vaughan and Black 2007) contains helpful information for reducing the impact of insecticides when they are used. If at all possible, avoid 'broad-spectrum' insecticides, which are toxic to insects in general. Apply insecticide on a calm day to minimize drift, and do not apply right to the edge of the field. Avoid use of micro-encapsulated insecticides (especially broad-spectrum ones), because forager bees will collect and bring them back to the nest. If using an insecticide toxic to bees, never apply it to a crop in bloom. If applying a less-toxic insecticide to a flowering plant, do so in the late evening, when bees are no longer foraging. Do not use more insecticide than the product's label recommends.

When pesticides are used, certain management practices can help to reduce the risk to pollinators. Avoid using pesticides on weeds unless they threaten crop production; weeds can be an important source of nectar and pollen. For example, Spanish needles (*Bidens pilosa*), common in much of the tropics and subtropics, is a nectar source for honey bees and may have other uses besides (Morton, 1962). For invasive weeds, spot treat them rather than broadcasting an herbicide, so that other plants will still flower and produce pollen and nectar for pollinators. Consider planting a green manure/cover crop that will flower; at ECHO's farm in Florida, bees are often seen on pigeon pea flowers. Finally, consider mulching to reduce weed growth without the need for herbicides.

***Neonicotinoids*** *are a class of pesticides that have been in the news in 2014. These are systemic chemicals, meaning that "they are absorbed by the plant and are transferred through the vascular system, making the plant itself toxic to insects." The chemicals persist long after application (even for months or years in the soil). In plants that have been treated with these chemicals, neonicotinoids are present in the pollen and nectar that bees collect. Some metabolites (the compounds that result when plants metabolize neonicotinoids) are at least as toxic to honey bees as the original compounds. Exposure to neonicotinoids may make bees more susceptible to parasites and diseases. (Information from http://nas-sites.org/pollinators/about-pollinators/). The European Commission has placed a two-year ban on three types of neonicotinoids.*

## Plant Bee-Friendly Flowers and Other Plants

Planting flowers is another concrete step to help encourage the presence of pollinators. Yards and roadsides are two places where flowers can be grown. *ECHO Asia Notes* #18 (September 2013) included an article about flowers that attract beneficial insects, including pollinators. The article mentioned several members of the daisy family that are known to attract beneficials, including cosmos, marigolds, sunflowers, coreopsis and coneflowers. The ECHO Asia Seed Bank offers seed of *Cosmos sulphureus*; African marigold (*Tagetes erecta*); and *Zinnia elegans*. Some of the crops featured in our ECHO Florida Seed Bank also attract

pollinators (see the "From ECHO's Seed Bank" section of this issue).

Farming practices can also provide habitat and a food source for pollinators. As mentioned in the previous section, some kinds of cover crops (such as clover and alfalfa) provide nectar for bees. Hedgerows can help break up a "pollen desert" caused by a single crop. Flowering brassicas (e.g. cabbage and broccoli) also attract an abundance of bees. When planting brassicas, consider allowing a few of the plants to flower.

In an article titled "Growing Insects," Richard Conniff described a blueberry farm in Michigan that was planted with rows of wildflowers between the rows of berry plants. As a result, the farm became home to lots of pollinator and predatory insects—and the farmer experienced less need for insecticides.

Finding the "right mix" of wildflowers to attract pollinators can be tricky. "Plants for Native Bees in North America," (Shepherd 2008) an Invertebrate Conservation Fact Sheet from the Xerces Society for Invertebrate Conservation (www.xerces.org), shares the following:

"To help bees and other pollinators—like butterflies—you should provide a range of plants that will offer a succession of flowers, and thus pollen and nectar, through the whole growing season. Patches of foraging habitat can be created in many different locations….Even a small area planted with the right flowers will be beneficial, because each patch will add to the mosaic of habitat available to bees and other pollinators."

The Xerces Society gives the following general guidelines for selecting good bee plants (reprinted from their website):

- **Use local native plants**. Research suggests native plants are four times more attractive to native bees than exotic flowers.
- **Choose several colors of flowers**. Flower colors that particularly attract bees are blue, purple, violet, white and yellow.
- **Plant flowers in clumps**. Flowers clustered into clumps of one species will attract more pollinators than individual plants scattered through the habitat patch. Where space allows, make the clumps four feet or more in diameter.
- **Include flowers of different shapes**. Bees are all different sizes, have different tongue lengths, and will feed on different-shaped flowers. Consequently, providing a range of flower shapes means more bees can benefit.
- **Have a diversity of plants flowering all season**. By having several plant species flowering at once, and a sequence of plants flowering through spring, summer, and fall, you can support a range of bee species that fly at different times of the year.

As you think about which plants to incorporate to help attract pollinators, also consider flowering perennials, especially indigenous species. At ECHO's farm, several perennials are regularly visited by bees when they are in flower. These include Yellow Poinciana (*Peltophorum pterocarpum*), *Clerodendrum* spp., *Jatropha integerrima*, and Firebush (*Hamelia patens*).

## Beyond Honeybees

Although honeybees have the largest profile as pollinators, they are certainly not the only insects important for pollination. According to a document by the FAO (2008), "…of the slightly more than 100 crop species that provide 90 percent of national per capita food supplies for 146 countries, 71 crop species are bee-pollinated (but relatively few by honeybees). Several others are pollinated by thrips, wasps, flies, beetles, moths and other insects."

The National Academies (http://nas-sites.org/pollinators/about-pollinators/) shares the following information about pollinators and their favorite flowers:

- **Bees** prefer blue or yellow flowers and those that are sweet-smelling.
- **Butterflies** like flowers that are red, yellow or orange. Scent doesn't matter; butterflies rely more on vision and less on scent to find nectar.
- **Hummingbirds** are attracted to red, orange or yellow flowers. Like most birds, hummingbirds do not have a highly developed sense of smell, so flower scent doesn't matter.
- **Bats** like flowers that are large and white or pale in color. Some bat-pollinated flowers are open only at night and typically have a fermented, fruity or musky scent.
- **Moths** are attracted to sweet-scented flowers that are typically large and white or pale in color. Some moth-pollinated flowers are open only at night.
- **Flies**. In tropical regions, flies are often found on pale, dark brown, or purple flowers that stink of dung or carrion. In temperate regions, they can be found on flowers of many colors, usually those that have easy access to nectar.
- **Wasps**' preferences are unknown.
- **Beetles** are typically attracted to flowers that are white or green and have a wide opening.

Many crops have very specific pollinators. The FAO, in collaboration with ICIPE, published an "Initial Survey of Good Pollination Practices" in 2008 (FAO 2008). The document contains information about "pollinator-friendly good agricultural practices," in an attempt to document such practices before they are lost, and to base conservation activities on practices that already exist locally. It includes case studies from various locations around the globe, illustrating how valuable it can be to understand the biology and physiology of a crop and its pollinators.

For example, papayas exist as male, female, or bisexual (flowers with both male and female structures). Fruits develop on female and bisexual trees, with variations in fruit shape between female and bisexual plants (Morton 1987). On small farms in Kenya, as described in the first chapter of "Initial Survey of Good Pollination Practices" (FAO 2008), the most saleable papaya fruits are those from female-flowered trees. The male-flowered trees offer nectar and provide the pollen that is needed by the flowers on female trees—so it is important to retain some male trees, even though they are less productive in terms of fruit. Papayas produce white flowers that release their scent after sunset, suggesting pollination by moths or bats, and in fact several varieties of hawk moth are primarily responsible for pollination. In order for hawk moths to flourish in the area, they require nectar sources that can feed adult moths throughout the year. Food plants are also needed for the hawk moth larvae, to ensure that the moths will be able to reproduce and maintain a presence in the area. In the Kenyan location described in the chapter, morning glories that grow on hedgerows provide nectar and also are larval host-plants—so encouraging growth

of morning glories can have a significant impact on papaya production.

## Provide Nesting Sites for Bees

Minimizing use of insecticides and providing flowers for pollinators have been discussed. Another action to help insect pollinators is to provide nesting sites for honey bees and for native bees.

Honey bees produce delicious honey while they pollinate, so encouraging their presence can be doubly advantageous. ECHO's Technical Note "Beehive Designs for the Tropics" contains descriptions and designs for several types of honey bee hives.

Nesting sites can also be made for other types of native bees. The Invertebrate Conservation Fact Sheet "Nests for Native Bees" (Shepherd 2012) presents ways to create nesting sites for native bees. These can be as simple as a bundle of reeds tied together and hung, or a wooden block drilled with a number of holes that vary in depth and diameter. Though geared toward North American native bees, the guidelines may be general enough to apply elsewhere as well. The Fact Sheet includes information about nests for wood-nesting and cavity-nesting bees, groundnesting bees, and bumble bees.

Throughout the tropics, stingless bees (Fig. 2) are important indigenous pollinators, especially in tropical America. These bees are in the family Meliponinae; there are hundreds of species. Individuals range in size from 2 to 13 mm, and colonies can include hundreds or tens of thousands of bees. In the wild, most stingless bees build nests in protective cavities using cerumen, a mixture of beeswax and plant resins. Stingless bees make small wax pots in which brood are raised, and somewhat larger wax pots in which they store honey. Historically, people have kept stingless bees in hollow logs, transferred from the forest.

***Figure 2.*** *A stingless bee, working a flower. Photo by Zachary Huang,* www.beetography.com

If also raising stingless bees for honey (in addition to keeping them for pollination), other factors should be taken into consideration when providing artificial hive space. In an article in *Bee World* called "Beekeeping with Stingless Bees: A new type of hive," Marinus Sommeijer (1999) describes the UTOB hive design, which largely separates the brood area and the honey-collecting area. This allows for minimal disturbance of the brood when honey is harvested, and also minimizes the likelihood that phorid flies will infest the brood. Though ideal dimensions will vary depending on the species of stingless bee, the basic design can be found at http://web.science.uu.nl/sommeijer/hive/hive.pdf.

For more information about stingless bee biology, see David Roubik's (2006) review article, "Stingless Bee Nesting Biology." In his article, Roubik quotes Roger Morse: "It is possible to keep bees in a hive only because we understand their biology. Beekeeping is the application of our knowledge of bee behavior." For online access to this and other documents mentioned in this article, see the references section below.

## Conclusion

Though insect pollinators have been declining over recent years, strategies exist that can help bolster their numbers. Look for alternatives to pesticides and, when necessary, use less-toxic pesticides applied in a manner that is least likely to harm insect pollinators. Plant flowers and use farming practices that will provide nectar for pollinators. Where feasible, provide suitable habitat for nesting sites. Read and learn about pollinators for crops that are of particular interest; an understanding of specific pollinators' biology and physiology can lead to targeted strategies for ensuring that a food source and nesting sites are available year-round.

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# FROM ECHO'S SEED BANK

## ECHO Plants that Attract Pollinators

*by Holly Sobetski, ECHO Florida Seed Bank Manager*

The ECHO Florida Seed Bank offers a wide variety of useful crops, many of which naturally attract pollinators (Fig. 3). Encouraging beneficial insects in your garden is a key component in promoting biodiversity, controlling unwanted pests and increasing pollination of your crops.

If you live in the tropics, you may have noticed that plants that are normally self- or wind-pollinated in cooler climates are often heavily visited by bees, wasps and other insects. Insect activity can result in some crossing, even between plants of a mostly self-pollinating crop. If you are growing plants for seed, therefore, you may need to isolate varieties. For the most part, though, the heightened insect activity is a great benefit of living where it is hot and humid.

### Tips and Suggestions:

**Allow plants to go to seed** that you normally wouldn't. On ECHO's demonstration farm, for example, we have noticed that this works well with plants in the Brassica family (broccoli, kale, cauliflower, mustard, cabbage, etc.). Interestingly, the flowers of many brassicas are "self-incompatible," meaning that fertilization can only occur when pollen is transferred between flowers from different plants. Pollen transfer between brassica plants occurs primarily through the activity of bees because the pollen of brassicas is heavy and sticky, making it unlikely to disperse in the wind. With their hairy bodies, bees are uniquely able to collect and transfer brassica pollen as they forage for nectar. A few other plants that attract beneficial insects when they go to seed are lettuce (*Lactuca* spp.), onions (*Allium cepa*) and carrots (*Daucus carota*).

**Plant local, indigenous flowering plants**. They may look like weeds, but the naturally-occurring plants in any given area are likely to be very attractive to resident insects, and could be grown to bring pollinators into local gardens. Select indigenous plants that are attractive to pollinators and that will not become weedy.

**Plant a variety of flower colors**, as insects are attracted to certain colors (see previous article).

### ECHO Florida Seed Bank plants that attract pollinators:

**Fruit Trees** are often pollinated by insects and draw a variety of bees, wasps, flies, butterflies and bats. ECHO has starfruit/carambola (*Averrhoa carambola*), loquat (*Eriobotrya japonica*), annonas (*Annona* spp.), tamarind (*Tamarindus indica*), strawberry tree (*Muntingia calabura*), Surinam cherry (*Eugenia uniflora*), papaya (*Carica papaya*) and others. Not only do these trees attract pollinators – they also depend on insects to transfer pollen for fruit production.

**Sunflowers** (*Helianthus annuus*). ECHO has several unique varieties of sunflower that will bring both beauty and busy insects to your garden.

**Pigeon pea** (*Cajanus cajan*) flowers are very attractive to bees. The plant is perennial and drought tolerant, producing forage for animals and legumes for human consumption. Pigeon pea grows into a large, tree-like shrub and fixes nitrogen for improved soil fertility.

**Roselle** (*Hibiscus sabdariffa*) is grown and used for its leaves (as a source of edible greens) or fleshy calyces (to make juice), but this annual shrub from the hibiscus family also produces showy pink flowers that insects love. Other vegetables in this family (Malvaceae) that attract insects are okra, cranberry hibiscus, jute mallow and kenaf.

**Herbs** do a wonderful job of bringing in a diverse population of beneficial insects. The ECHO Florida Seed Bank offers basil (*Ocimum basilicum*), oregano (*Origanum vulgare*), dill (*Anethum graveolens*), parsley (*Petroselinum crispum*) and cilantro (*Coriandrum sativum*).

### To Order Seeds:

Log on to www.ECHOcommunity.org and register as a member. Individual Premium members and Active Development Worker members can view the seed catalog by clicking on the tab "Seeds" on the left hand side of the screen. Choose "ECHO FLORIDA SEED BANK" and then "ECHO Seed Catalog." Search for plants by scientific name, common name or crop type. We also offer five seed bundles for specific regions and situations. Add the items you want to your cart and then go through the check-out process. If you are an Active Development Worker, use the "Contact Us" button to ask about free packets of seeds.

***Figure 3.*** *A bee on the flower of a moringa tree. Photo by Tim Motis.*

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*Nathanael Szobody submitted the following in response to an update in EDN 123 on research ECHO is doing in South Africa. We thought these comments were particularly interesting and insightful, as they illustrate the contribution that farmers can make to further our understanding of agricultural practices such as intercropping. We appreciate the time that Nathanael took to observe what was going on in a farmer's field and to send ECHO a written assessment. Below, Nathanael's comments are interspersed with notes by Tim Motis; the latter are in italics and within square brackets.*

***Figure 4.*** *Cucumbers planted under okra (left) and growing into the space under roselle (right). Photos by Nathanael Szobody, illustrating practices in his garden.*

Nathanael wrote, "I appreciated the data presented by Melissa Miller and Tim Motis in *EDN* 123 concerning the benefits of planting cowpeas as living mulch under maize to help cool the ground. A short while after reading the article, I noticed my neighbor's sorghum and corn fields in our village of Sub-Saharan Chad. He had planted native varieties of domestic cucumbers in the very same holes as his sorghum and maize. While it was aesthetically pleasing to see the green cucumber foliage cascading from the base of the sorghum stalks and spreading out to cover the surrounding earth, I was skeptical of the association. I suggested that if he were to plant the cucumber *between* the rows of grain crop, or at least between the individual grain plants in the row, there might be less competition between the two crops and [they might] be mutually beneficial. Not so, he countered. His reasoning? The dense cucumber foliage cools the sorghum and maize roots from their first days of growth on. He assured me that the plants with cucumbers at their roots produce just as well if not better than those grown alone. Indeed, the cucumber is an ideal ground cover. Its creeping vines systematically branch at regular intervals so that the perimeter of its leaves all touch each other in a growing radius, sealing a low canopy to protect the fruit underneath (and the soil!) from the hot sun. Local cucumber foliage is so dense, thieving monkeys have to resort to rolling around on the plants to find the hidden cucumbers."

*[Tim Motis (TM): These observations in Chad are consistent with what we found with cowpea grown with maize in our plots in S. Africa. As mentioned in EDN 123, soil temperature was 5 degrees cooler with maize/cowpea than maize alone. As it turned out, volumetric soil moisture was also slightly higher with maize+cowpea (4.9%) than maize alone (4.5%) at the 12th week after planting maize. Apparently, the amount of water conserved through shading/mulching the ground exceeded the amount of water lost to transpiration (movement of moisture through the leaves to the atmosphere).]*

Nathanael continued, "The method needs scientific testing under appropriate controls. But I found his testimony compelling as I discovered others employing similar practices (Fig. 4). While helping a friend hoe his millet field I was fascinated to watch his grandma meander through the field planting cucumber in between the millet sprouts. Neither extra profit nor enhanced millet production were in her calculation: 'When it comes time to hoe the millet we're going to get hungry, so we had better have some cucumbers to munch on.' Yet her approach was also precise and well informed in terms of symbiosis; cucumber and millet do well together, but squash is best planted among the peanuts, she explained. Gumbo (okra) also does well among the peanuts, where the gumbo seed is simply broadcast in a freshly plowed and planted peanut field. This makes sense in terms of ground temperature: from my experience gumbo benefits greatly from cooler soil. Densely planted peanuts accomplish that effect. Additionally, gumbo is heavily tap-rooted and therefore competes minimally with the surrounding peanuts.

"While cucumber is not a legume and therefore does not have the benefit of adding nitrogen to the soil, crop rotation can have the same benefit.

"Additionally, cowpea foliage is very hardy and, left on the ground after harvest in any Sub-Saharan region, will be consumed by nomadic herds rather than having any lasting effect on soil humus (other than the manure dropped in the process, which is not a negligible factor). Whereas cucumber will be harvested long before the grain crop, its dead foliage is much more fragile than that of cowpea, disintegrating rapidly in the presence of precipitation and providing the soil with nutrients and humus before the nomadic herds have an opportunity to graze the fields."

*[TM: It is helpful to be aware of the time it takes for leaves and stems of a cover crop to degrade. The rate of decomposition of crop residues influences when and how quickly minerals are released into the soil. Foliage that persists a long time can be helpful from the standpoint of keeping the soil covered; however, nutrient release is slow. Factors that affect degradation rates of cover crop residues include leaf thickness (e.g., thin velvet bean leaves degrade faster than jack bean leaves), growth cycle of the crop (e.g., lablab produces most of its biomass later in the season than cowpea), temperature, and rainfall. As Nathanael's comments illustrate, in addition to understanding principles of decomposition and nutrient release, it is important to take into account human and animal activities that affect the contribution of residues to the soil.]*

Nathanael also shared: "Furthermore, the subsistence farmer and her family benefit more from nutritional diversity than market diversity. Cucumber is a very good source of vitamin C, vitamin K, and potassium, and is also a good source of vitamin A—the latter being particularly lacking in the Sub-Saharan diet, perhaps contributing to a high rate of eye disease in that region. While cowpeas, with the protein they provide, are a dry good and are available at a reasonable price year-around, Sub-Saharan Africans

are most often deficient in less-affordable and only seasonally available vegetables and fruit. Therefore it is wise to benefit from the high-producing local cucumber varieties when the season permits."

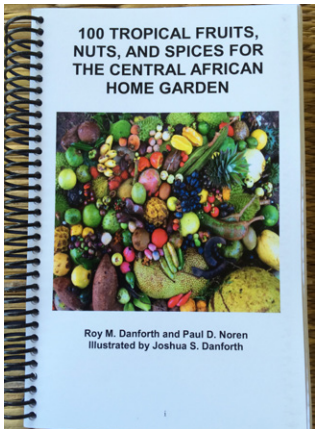
*[TM: We have noticed in a legume screening trial that the yield of successive cowpea plantings on the same plots has declined over time. Also, root knot nematodes have been more prevalent in cowpea plots than in velvet bean and lablab plots. When incorporating cover crops into farming systems, we need to think about ways to avoid the buildup of pests. A (non-leguminous) cucurbit ground cover could be rotated with leguminous ground covers.]*

Nathanael concluded, "The beauty of using cucumber as a ground cover in this way is that it doesn't take an outsider to tell people how to do it; it is a well-known and labor-minimal method whose increased implementation needs only a little encouragement."

# BOOKS, WEBSITES AND OTHER RESOURCES

## 100 Tropical Fruits, Nuts, and Spices for the Central African Garden

*by Roy M. Danforth and Paul D. Noren*
*Reviewed by Bob Hargrave*




Roy Danforth and Paul Noren have over 30 years of experience in the forests of the Democratic Republic of Congo, the Central African Republic and Cameroon. Over the years they have collected seeds from the forests, obtained seeds through gifts and exchanges, and established over 500 different kinds of trees. This book is a compilation of 100 of the most promising fruit trees for a Central African Home.

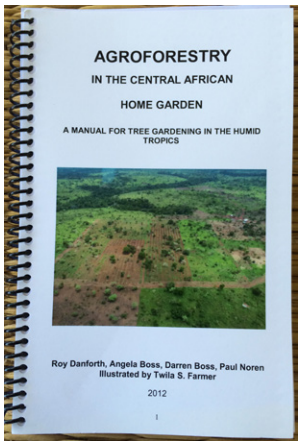
The reader will be familiar with some of the trees, such as mango, avocado, guava, cashew and loquat. Few will have heard of indigenous trees like "ndea" and "dolea," about which little is known. Many of the other included fruit trees originated in Latin America or Asia.

The book is organized alphabetically by scientific names. Each species entry contains information about common names, a description, growing conditions, production, cultivation, uses, nutritional value, and medicinal value. Most species are also illustrated beautifully by Joshua Danforth.

This book is intended to help people in similar climates review and select trees that might serve as an important addition to their garden and improve nutrition.

## Agroforestry in the Central African Home Garden: A Manual for Tree Gardening in the Humid Tropics

*by Roy Danforth, Angela Boss, Darren Boss, and Paul Noren*
*Reviewed by Bob Hargrave*

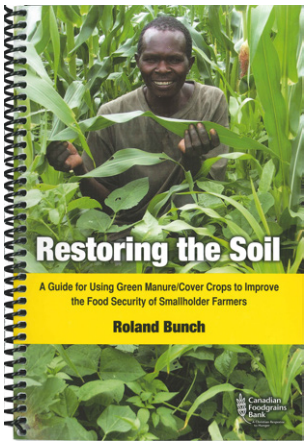



This book serves as a companion to *100 Tropical Fruits, Nuts, and Spices for the Central African Home Garden*. Drawing on over 30 years of experience in Central Africa, Roy Danforth and fellow authors have developed this manual to guide people in establishing a variety of multi-purpose trees in the agricultural landscape.

The book is organized into 16 very practical lessons covering everything a farmer or development worker would need to know in order to plant, cultivate, multiply and manage trees in a home garden or field. This book would be a valuable resource for an individual farmer, and also serves as an excellent lesson series for teaching farmer groups or organizing cooperatives.

Both of these books are available through the ECHO online bookstore (www.echobooks.net), for $20 and $15 respectively. Alternatively, contact Roy Danforth at royaleta@gmail.com.

## Restoring the Soil: A Guide for Using Green Manure/ Cover Crops to Improve the Food Security of Smallholder Farmers




The paperback form of this book, by Roland Bunch, continues to be available through the ECHO bookstore (www.echobooks.net). It is now also available online as a pdf document that can be downloaded free of charge. For access to this valuable resource, visit: http://foodgrainsbank.ca/uploads/Restoring%20the%20Soil.pdf

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# UPCOMING EVENTS

## 21st Annual ECHO International Agriculture Conference

*November 18 - 20, 2014 (note date change from previous years)*

*Fort Myers, Florida*

Speakers will share practical solutions to agricultural challenges, personal experiences and strategies for improving the lives of millions who daily face the threat of starvation. The event offers an open exchange of information, connecting the people and ideas that can make a real and sustainable difference.

Morning plenary sessions focus on practical ideas that have proven successful in communities around the world. This year's speakers and their topics include the following:

- **Biochar for Control of Trace Contaminants in Water** (Josh Kearns)
- **Custom Hay Baling as a Business for Former Street Children in the Kenyan Highlands** (Sjoerd W. Dulker, PhD)
- **Carbon Farming** (Eric Toensmeier)
- **Intercultural Team Leadership** (Sara Lanier)
- **Sustainable Development, Animal Agriculture, and Ecological Restoration** (Robert Pelant, DVM)
- **Creation Care as an Integral Part of Mission** (David Gould)
- **Simplified Low Pressure Drip Irrigation to Raise Small Farm Incomes** (Brent Rowell, PhD)
- **Becoming a Crop Champion** (Penny Rambacher, R.D.)
- **Seed Exchange** (Laura Meitzner Yoder)

For those who are able to stay an extra day after the conference, consider attending a post-conference workshop on Friday, November 21. (An additional fee applies.) Topics this year will include: cross-cultural skills; biochar water filters, and perennial crops (participants choose one).

## ECHO East Africa Highlands Symposium

*October 28 - 30, 2014*

*Bujumbura, Burundi*

You are invited to participate with others from across the region at an East Africa Highlands Symposium, to share unique knowledge appropriate to farming in the highlands. This three-day training and networking event will be a valuable time of learning, information sharing and networking for those working and serving in the high elevation areas of East Africa.

Three mornings of plenary sessions featuring knowledgeable and experienced speakers will be followed by afternoon workshops and discussion groups led by regional agricultural development workers and experts. Please plan to attend and encourage others who might benefit to join us as well.

## Forum Ouest Africain/West Africa Networking Forum 2015

*January 27 - 29, 2015*

*Ouagadougou, Burkina Faso*

This ECHO Forum (FRENCH LANGUAGE ONLY) will encourage networking related to alleviating hunger and poverty by those persons serving Africa's poor. Three mornings of plenary sessions featuring knowledgeable and experienced speakers will be followed by afternoon workshops and discussion groups led by regional agricultural development workers and experts. Topics to be addressed include:

- Foundations for Farming - Theory and practice (extended sessions)
- Major challenges and solutions in African agriculture
- Grafting
- Food production and nutrition for animals
- Useful agricultural plants in sub-Saharan region
- Moringa and other useful life-giving plants

Check ECHOcommunity.org for any date changes.

## ECHO East Africa Symposium

*February 3 - 5, 2015*

*Arusha, Tanzania*

The ECHO East Africa Symposium will provide a network and training opportunity for those involved in alleviating hunger and poverty in East Africa. Three mornings of plenary sessions featuring knowledgeable and experienced speakers will be followed by afternoon workshops and discussion groups led by regional agricultural development workers and experts.

## Looking ahead:

### TAD I

In 2015, our introductory Tropical Agricultural Development course will be held on the following dates:

January 19 – 23
June 1 – 5
July 27 – 31

### TAD II

Tropical Agricultural Development II, Basic Gardening for the Tropics, will be held June 22 – 26.

TAD II, Appropriate Technology (AT), will be held August 17 - 21.

*Further information on these events and links for registration are available at* 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!**