ECHO® Development Notes

Edited by Dawn Berkelaar and Tim Motis | July 2017 | Issue 136

Crop monitoring for early detection of insect pests

by Clare Liptak and Dr. Timothy Motis

Editors: Insects and other pests can be a serious constraint to food production, especially where resources for pest management are scarce. For example, in EDN 133, we responded to a question about problems with tomato leaf miner (Tuta absoluta) in Nigeria. Heavy infestations of this pest alone can reduce yields by 80 to 100% (Gebremariam 2015). The following article begins an effort to strengthen our informational resources on pest monitoring and management.

GENERAL PRINCIPLES AND PRACTICE

by Clare Liptak, horticulturalist and retired Associate Professor with Rutgers University

What is crop monitoring?

Monitoring is the regular and careful inspection of crop plants throughout the growing season; when monitoring, a farmer walks through his/her crop to look for plant problems such as insects and mites, diseases, weeds, storm damage, and environmental stresses such as drought or nutrient deficiencies. This article focuses specifically on monitoring crops for insect pests.

Why monitor your crops?

Finding problems early gives a farmer time to resolve them before the crop sustains serious damage. With short-term vegetable crops like tomato, early detection of pest problems is critical to enable timely decisions before it is too late. If the pest is not one the farmer recognizes, early detection will mean there is more time to have it identified correctly. Poor monitoring of crops can lead to substantial crop losses.

Monitoring allows for timely and efficient use of pest management inputs. Many insecticides, whether purchased products or farmer-made extracts of various plants, work best—and are less likely to have negative environmental impact--when the pest population is small. Many

Figure 1. Magnifier with two lenses. *Source: Clare Liptak*

also work best at a certain stage of pest development. For example, timing of Bt (*Bacillus thuringiensis*) spray applications is critical for controlling pests such as African armyworms (*Spodoptera exempta*). Since the Bt bacterium must be ingested by the target insect, it should be applied when young caterpillars are actively feeding.

It is also helpful to be aware of beneficial insects that could help control a plant pest; see the "References and Further Reading" section at the bottom of this article for links to photos of and information on common beneficial insects. Such knowledge may influence a farmer to adopt practices that favor natural allies against crop pests. For example, if a farmer notices hoverflies (Syrphidae family) in the field, they may want to allow flowering plants such as sunn hemp (*Crotalaria* sp.) to flourish around the field (Infonet biovision 2016, Wang 2012). Hoverfly larvae feed on aphids and small caterpillars, while the adults are attracted to flowers and are good pollinators.

Monitoring tools

Eyesight and an inquiring mind are the most important tools; however, it helps to have the basic items listed below:

- A magnifying glass for observing small insects or insect eggs
- A jar or plastic bag to collect insect specimens for later examination
- Flagging tape or strips of cloth to mark insect-damaged plants
- A pencil and notepad to record observations

I have a magnifier purchased about 20 years ago from NASCO. It now retails for $6.85 and has two lenses: one lens (5X) allows me to see most insects, and when using both lenses together (10X) I can see most insect eggs. I've managed to keep it so long because, in the unfolded position, I thread a shoelace through it so I can wear it around my neck while monitoring (Figure 1). In the United States, high quality hand magnifiers made specifically for studying insects cost $30 to $50 from BioQuip. Any magnifying glass will work; cheaper options are likely to be available where office supplies are sold.

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Since I am right-handed, I hold the hand lens in my right hand, with the long bone of my thumb on my cheek, so the hand lens is still. Then with the specimen in my left hand, I move it closer and farther away from the lens until the specimen is in focus.

How to monitor?

Regularly walk the entire garden or field

Of course when watering or weeding, farmers are also looking for pest problems, but it is helpful to walk the entire planting or field at least once each week specifically to monitor. Each time a farmer enters their field to monitor, she or he should look for signs of the specific pests that would most likely be there depending on the stage of crop development and time of the growing season. It helps to sometimes enter the field or plot from a different starting point. For example, while walking with the sun at your back, you will see different things than if you always walk facing the sun.

Thoroughly check a few plants

It isn't necessary to check every plant, but check random plants thoroughly in problem areas first, looking at the upper and lower surface of leaves. There may be more than one pest, and the most obvious pest may not be the cause of the plant damage. The number of plants to examine and what to look for varies with the crop and the pest. (OISAT [Online Information Service for Non-Chemical Pest Management in the Tropics] provides a tool that lists, for a number of different crops, important insect pests to look for at various crop growth stages.)

Strive for consistency

Personal impressions are the basis for crop management decisions. Two people may have different opinions on how many insects constitute a small versus moderate infestation. For this reason, it is best that the same person monitors the crop throughout its development. Alternatively, two people could work together, discussing and agreeing on a monitoring approach before walking the field or garden.

Distinguish between biotic and abiotic problems

Pay special attention to clues that allow you to distinguish pest problems from non-pest, or environmental, conditions. Insects, diseases, mites, rodents, etc. are all biotic, which means "resulting from living things." Environmental conditions such as drought or flooding are "abiotic," meaning they are not caused by living things.

Biotic problems often appear random, especially in the beginning stages—leaves here and there show spots, for example— while abiotic conditions can be very dramatic. An insect problem may start with just a few caterpillars and evidence of feeding damage on a few plants, while droughty soils may cause an entire plant, or group of plants, to wilt or dry up. Biotic problems are also most likely to affect specific or closely related crops. A biotic problem affecting tomato, for instance, would not typically affect maize because those crops are not related. (Tomato leaf miner is an exception to this general rule, as it not only feeds on plants in the Solanaceae family (e.g., tomato and potato), but has also been found on common beans (*Phaseolus vulgaris*), which are in the Fabaceae family.) In contrast, abiotic problems often affect unrelated crops and even weeds in the same area.

Record observations

In the beginning of the season, draw a map of the field with crops (and even different cultivars of one crop) placed as exactly as possible. This can be used to mark where insect problems occur in the field. Some farmers use a new map to make the notes for each monitoring visit. Others use a separate log for entries. Regardless, for each monitoring visit, note the date and weather conditions, the stage of crop development, and any other information that would be helpful later on in making pest management decisions.

Keep in mind that these notes become the farmer's best tool to increase their expertise; no one will be as knowledgeable about their land as they are. Like anything else, proficiency comes with practice. My early sets of notes were mostly full sentences, no abbreviations, and few observations of the surrounding environment. But in later years, I abbreviated more. *[Editors: If a farmer is unable to write, much can still be learned and remembered through consistent monitoring, and there may be non-literary recording techniques already being used within the community, such as drawing.]*

USE OF MONITORING TRAPS

by Tim Motis, based on an ECHO trial conducted by Stacy Reader and Christine Paul

Relevance of traps for insect monitoring

Walking through a field to observe pest problems is an important part of any monitoring approach. However, many insects are active at night when it would not be practical for a farmer to be in the field or garden. There are also days when the farmer is away. These limitations are overcome, at least in part, by using any type of container or device that traps enough insects to give the farmer an indication of what pest species are present.

Monitoring traps function day and night and can be made with local materials, such as plastic water or juice bottles. Traps can be placed to target various types of insects. Above-ground traps catch flying insects, before they lay eggs that hatch into larvae/caterpillars that decimate plant leaves. Traps placed at the soil line are good for monitoring ground-dwelling insects hidden in leaf litter or mulch.

Figure 2. Dishpan (left), pitfall (middle) and sticky paper (right) traps used for monitoring insects in a sorghum field at ECHO. *Source: Tim Motis*

How they work

Monitoring traps frequently make use of an attractant or lure. This is often done through the use of colors to which insects are attracted. Yellow objects attract many kinds of insects, including natural enemies of insect pests (Mizell 2014). If large numbers of beneficial insects are found in a monitoring trap, reduce the number of traps or try a different color. Other colors commonly used for monitoring traps are blue and white.

Insects can also be attracted to baits that are liquid (e.g., sugar dissolved in water) or solid (e.g., fruit slices or animal dung). Containers are typically filled with water, until 2 cm below the top of the container. Once insects are drawn into a trap, they eventually fall into the water. Add some liquid dish detergent to the water to help prevent trapped insects from escaping. One spoonful (about 15 ml) of dish detergent per container of water should be plenty; use unscented brands to keep smell from skewing the number of trapped insects. As an alternative to using containers, colored pieces of paper or cardboard can be painted with something sticky, like molasses, to capture insects.

Some traps lure specific species of insects with pheromones, which are compounds that insects release to attract a mate, signal alarm, or mark a food trail. Depending on the lure, they can potentially attract insects from far away. Pheromone traps may be available to farmers in some countries, depending on the existence of laboratories that produce the pheromone compounds. This article focuses on traps and baits that farmers can make themselves.

Traps trialed by ECHO in 2016

Many types of traps can be made. For this small trial, we focused on three types:

1) **Dishpan trap**, consisting of a container filled half-way with soapy water made by mixing 30 ml (2 tablespoons) of liquid dish detergent with 400 ml of water. Jugs could be filled and hung on stakes or fruit tree branches. For this trial, we simply placed a round container on the ground.

2) **Pitfall trap** made by filling a container with water and molasses (our traps were filled with 450 ml water + 450 ml molasses + 15 ml of dish soap), with the container buried so that the top of it is flush with the surface of the ground. A banana leaf was placed over the top of each pitfall trap to keep debris from falling in.

3) **Sticky paper traps** made by painting molasses onto a yellow piece of paper from a manila folder (about the thickness of cardstock).

The traps were placed in between rows of sorghum at ECHO's Global Demonstration Farm in southwest Florida. The sorghum plants were close to harvest stage, with a noticeable abundance of insects present. Two of each of the above-mentioned traps were placed in each of three locations in the sorghum plot. Insects were counted after two days; if you wait much longer than that, trapped insects start to deteriorate, making identification and counting more difficult.

Performance of traps trialed by ECHO in 2016

The dishpan traps captured more insects (Figure 3), as well as a greater diversity of insects (Figure 4), than the pitfall and sticky traps. Vrdoljak and Samways (2012) reported that pan traps are a good method for monitoring multiple species of insects. They found that yellow and white pan traps captured a large diversity of insects that visit plant flowers. However, they suggested adding other colors to avoid the possibility of over estimating insects drawn to just one or two colors.

The dishpan traps caught pests such as thrips (species of the Thripidae family) and whiteflies (species of Aleyrodidae family). They also caught beneficial insects including ladybugs (species of the Coccinellidae family; most likely *Harmonia axyridis*) (Figure 5) and long-legged flies (species of the Dolichopodidae family), which feed on aphids and thrips. You might catch beneficial insects as well as pest species, but a few small monitoring traps will probably not significantly reduce populations of beneficial insects. Other than pheromone traps, we did not come across any designs that exclude beneficials.

Beetles (not identified to genus and species level) were more consistently captured with the pitfall than the other two trap types. Perhaps pitfall traps could be used in combination with above-ground traps to monitor both ground-dwelling insects and those present in the crop canopy. Whether a farmer uses more than one type of trap or multiple colors of different traps, we recommend a combined approach for reliable and early detection of insect pests.

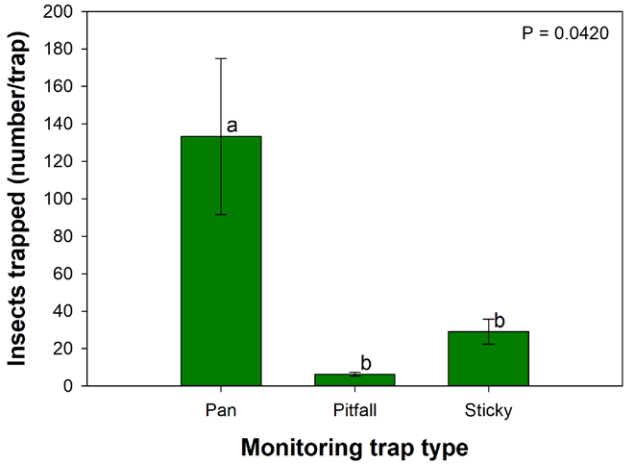

Figure 3. Number of insects captured with dishpan, pitfall, and sticky paper monitoring traps trialed at ECHO in southwest Florida. Data are the average of six replications. Any two bars with a different corresponding letter ("a" or "b") represent statistically different values; those with the same letter represent statistically similar values.

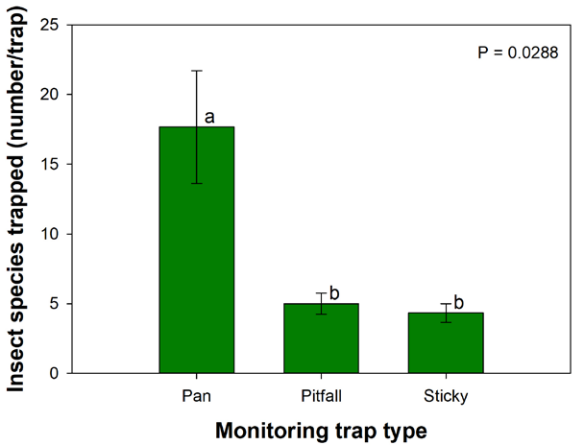

Figure 4. Number of insect species captured with dishpan, pitfall, and sticky paper monitoring traps trialed at ECHO in southwest Florida. Data are the average of six replications. Any two bars with a different corresponding letter ("a" or "b") represent statistically different values; those with the same letter represent statistically similar values.

Potential improvements

The molasses used with our sticky traps lost its stickiness after the first 24 hours. Boiling the molasses beforehand (to remove water), or adding flour or cornstarch (to thicken it) might help prolong stickiness. We have also learned that used motor oil is often used instead of molasses.

Dishpan and pitfall traps could be covered with screen mesh to keep leaves from falling into them. In our trial, falling leaf litter was not much of an issue. If monitoring traps are being used during the rainy season, a plastic bottle or jerry can might work better than a pan; a 2 to 4 cm-wide slit cut into the side, at least 6 cm above the bottom of the container, would limit exposure to rain drops but still allow insects to enter.

Many other trap designs, placement strategies and baits could be tried. An article by Infonet Biovision, entitled Traps and Bagging, is a good place to look for practical suggestions.

Figure 5. Ladybug (*Harmonia* sp.) larva (top) and adult (bottom) observed on sorghum leaves at ECHO in Florida. Note the larva feeding on aphids. *Source: Tim Motis*

References and further reading

DOCUMENT OR WEBSITE	SUMMARY NOTES
Integrated Pest Management	
FAO (Food and Agriculture Organization of the United Nations) website on Integrated Pest Management.	Links readers to FAO programs related to IPM, as well as IPM-related efforts that the FAO has undertaken in various parts of the world.
UC IPM (University of California Integrated Pest Management) website.	Contains extensive information on crop pests, pest identification, and insect management. Many of the insects featured on this website are common throughout the world.
Beneficial Insects	
Mizell, R. 2014. Tools for Trapping Pests and Attracting Beneficial Insects. Panhandle Ag e-News (University of Florida IFAS Extension).	Discusses the use of yellow objects to attract beneficial insects.
TECA (Technologies and practices for small agricultural producers) document entitled *Beneficial Insects and the Cotton Pests They Control.*	Provides photos of common beneficial insects, along with a list of insect pests that they help to control. Insects shown here are often encountered in other crops besides cotton.
UC IPM (University of California Integrated Pest Management) *Natural Enemies Gallery.*	Presents information on natural enemies of various insect pests.
Wang, K.-H., 2012. Cover Crops as Insectary Plants to Enhance Above and Below Ground Beneficial Organisms. Hānai'Ai/The Food Provider.	Provides insights in how to integrate flowering cover crops into farmers' fields for the purpose of attracting beneficial insects.
Lingbeek, B.J., CL. Higgins, J.P. Muir, D.H. Kattes, and T.W. Schwertner. 2017. Arthropod diversity and assemblage structure response to deforestation and desertification in the Sahel of western Senegal. *Global Ecoloogy and Conservation* 11:165-176.	This paper is authored by former ECHO intern and staff member, Brandon Lingbeek. It sheds light on the use of pitfall traps to monitor insect diversity in the Sahel. Section 2.2 explains how their pitfall traps were designed and implemented.
Insect Pests and General Information	
Gebremariam, G. 2015. *Tuta Absoluta*: A Global Looming Challenge in Tomato Production, Review Paper. *Journal of Biology, Agriculture and Healthcare* 5(14):57-62.	A review of the literature on tomato leaf miner.
Infonet biovision website.	Contains a wealth of information on pest control, covering approaches including natural enemies, neem extracts, soap spray, garlic and neem extracts, and insect monitoring traps. On the home page, find and click on "Plant" or "Plant Health" to find information about crop pests and management approaches.
OISAT (Online Information Service for Non-Chemical Pest Management in the Tropics).	Lists pests affecting specific crops, with links to photos and additional information about insect pests and ways to control them. Also has information on crop diseases.
TECA (Technologies and practices for small agricultural producers) document entitled *Pest and Disease Management in Organic Agriculture.*	A section on crop monitoring explains what to look for as far as crop damage caused by insects. There are also sections on insect monitoring traps and ways to enhance natural enemies of insect pests.
Vrdoljak, S.M. and M.J. Samways. 2012. Optimising colored pan traps to survey flower visiting insects. *Journal of Insect Conservation* 16(3):345-354.	A research report on pan monitoring traps that promotes multiple colors and contains a thorough review of literature pertaining to pan traps.

A mystery lychee-related illness is solved

by Dawn Berkelaar

For 20 years, an area in eastern India was the site of a mysterious, sudden-onset, neurological illness that affected apparently healthy young children, resulting in seizures, comas and (in 40 percent of cases) death. This pattern occurred starting in mid-May, and ended in July with the arrival of monsoon rains.

The cause of the illness—extremely low blood sugar resulting from consumption of lychees (*Litchi chinensis*) on an empty stomach—was identified by India's National Center for Disease Control and the India office of the Centers for Disease Control and Prevention in Atlanta. A recent article in The Lancet describes the investigation and the conclusions reached by researchers.

Most of the children admitted to the hospital had normal white blood cell counts and no evidence of infection. No evidence of pesticide toxicity was found. Most of the children had low blood sugar levels. A similar symptom is associated with unripe ackee fruit (*Blighia sapida*), which contains a toxin called hypoglycin that disrupts fatty acid metabolism and leads to low blood glucose levels. Children affected by the illness had abnormal levels of hypoglycin in their urine, but it was from lychees rather than ackee fruit; the area affected by the mystery illness has numerous lychee orchards. Lychees have been found to contain hypoglycin (and another similar toxin abbreviated as MCPG), with unripe fruits containing more of the compounds than ripe fruit.

The Lancet article demonstrated an association between the neurological illness and the consumption of lychees on an empty stomach (i.e., the two were related). But the research also makes a case for causality (that is, that the consumption of lychees on an empty stomach resulted in the neurological illness). Based on the results, the authors of the article recommend that 1) young children are encouraged to always eat an evening meal; 2) consumption of lychees by young children is limited; and 3) in cases of sudden-onset neurological illness, low blood sugar be checked for and addressed.

Prior to reading this article, we had not heard of potential negative effects from eating large quantities of lychees at the exclusion of other foods. This situation underscores the importance of eating a diverse diet. Do not be overly alarmed by this research. ECHO staff member Rick Burnette commented, "Despite having lived and worked in lychee-land [Thailand] for years, this was the first time I had heard of such cases."

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Do all parts of a chaya plant contain hydrocyanic acid?

by Stacy Reader and Tim Motis

Chaya cooking trial

Leaves of tropical crops like chaya (*Cnidoscolus aconitifolius*) and cassava (*Manihot esculenta*) contain cyanogenic glycosides, toxic substances that release hydrocyanic acid (HCN; also referred to as cyanide or prussic acid) when cells are crushed. Consuming these plants without cooking them can cause cyanide poisoning, with effects that vary depending on cyanide levels and how long a person or animal has been eating that plant. An information sheet from the New Zealand Food Safety Authority describes cyanogenic glycosides in plants and their effect on human health. To determine if a plant is safe to consume, a simple cyanide screening test using Cyantesmo paper is very helpful.

Figure 6. Coarsely chopped chaya plant parts (top) and bag placement (bottom). Note the Cyantesmo test strips placed in bags. *Source: Tim Motis and Stacy Reader*

Cyantesmo paper can be cut into short strips and placed in a sealed bag or container along with plant material, to detect the presence or absence of HCN. If the paper turns blue, HCN is present. The color change is not specific enough to indicate parts per million; however, smaller concentrations of HCN will result in a lighter shade of blue than higher concentrations. See *EDN 130* for more information on how to use Cyantesmo paper.

In September of 2015, we found that it took between 15 and 20 minutes of boiling time to no longer detect HCN in chaya leaves. Since that time, ECHO Asia Technical Advisor Karis Lotze noted that both petioles and green stems are also consumed in parts of Asia. She asked, "Is HCN present in the petioles and green stems? And if so, how long do these plant parts need to be boiled in order to be safely consumed?"

To answer Karis's questions, we repeated the 2015 trial in June 2017 with the addition of chaya petioles, green stems and roots. (Roots are not commonly consumed or recommended for consumption, but we included them in order to understand plant allocation of cyanogenic glycosides throughout plant tissue.) Eighty grams each of fresh chaya leaves, leaf petioles, and green stems were chopped up and placed in quart-sized Ziploc® bags as shown in Figure 6. Due to limited quantity, only forty grams of fresh chaya roots were chopped up and used.

To determine for how many minutes each plant part needs to be boiled in order to be safely consumed, eighty-gram samples of chaya leaves, petioles and green stems were boiled separately in one liter of water for 10, 15, and 20 minutes. Forty-gram samples of chaya roots were boiled in one-half liter of water for each time interval. For prolonged boils, extra water was added as necessary to keep roots covered with water. After boiling, samples were placed in Ziploc® bags with test strips.

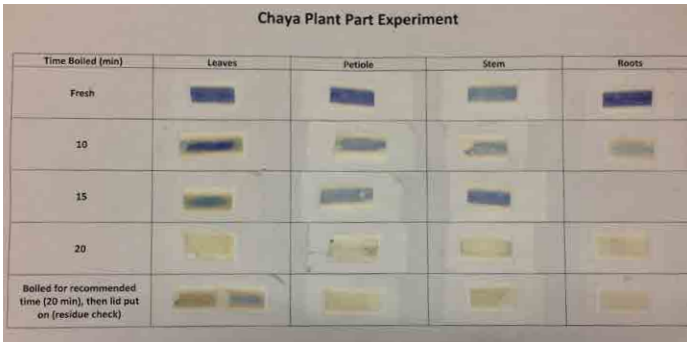

Figure 7. Results from second experiment determining safe cooking times for chaya petioles and stems. Roots are not consumed, but show lower cook time for cyanogenic compound removal.

Results shown in Figure 7 confirm the previously determined safe cooking time of 20 minutes for chaya leaves. Results show that chaya petioles and green stems also require a boil time of 20 minutes to remove cyanogenic compounds. Although fresh roots indicated high concentrations of HCN release, a 10-minute boiling time reduced cyanogenic compounds substantially in root material.

Some ECHO staff members recommended checking the cooking water, to determine if the water is safe for consumption after boiling chaya plant parts. We repeated the trial, again using 80g of chaya leaves, petioles and green stems boiled in one liter of water and 40g of chaya roots in one-half liter of water. After boiling for the recommended 20 minutes to remove cyanogenic compounds from each plant material, we brought the remaining water back to a boil, then removed the pots from the heat source. We fixed lids with two strips of Cyantesmo paper using clear tape, and put them on the pots. Papers were left on the lids for 17 hours before the color was checked. Results show that only water used to cook chaya leaves still contained trace amounts of cyanogenic compounds. This trace indication may have come from leaf residues stuck to the pot.

Additional Questions

We have additional questions about chaya, outlined below. If you have input about these, or have your own questions, please share your ideas with the network in the chaya category of ECHOcommunity Conversations.

East Africa Regional Impact Center Director Erwin Kinsey asked, **"Does finer chopping of the chaya plant part reduce cooking time?"** Since chopping ruptures cells, it would make sense that the HCN would be released more quickly with finer chopping, but we would like to test this hypothesis. http://edn.link/39wr7a

We have heard from various word-of-mouth sources that some individuals get sick (diarrhea with or without vomiting) after eating chaya that has been cooked in aluminum pots. **Does cookware material have an effect on toxicity or other illness?** http://edn.link/4panwp

ECHO's Appropriate Technology Manager, Elliot Toevs, posed another question: **"Do different cooking and processing techniques other than boiling (such as frying in oil or drying into powder) also release HCN? If so, how long do these processing methods take before chaya parts can be safely consumed?"** http://edn.link/jjj2qc

A combination of chopping and 3-day wilting before drying was effective in lowering the cyanide concentration of cassava leaves from 1436 to 55 ppm HCN (Ravindran 1987). Chopping and wilting might have a similar effect for chaya leaves.

References

Ravindran, V., E.T. Kornegay and A.S.B. Rajaguru. 1987. Influence of processing methods and storage time on the cyanide potential of cassava leaf meal. *Animal Feed Science and Technology* 17(4):227-234.

ECHOES FROM OUR NETWORK

Farming as a Family Business

Sara Delaney is a Senior Program Officer of International Programs with Episcopal Relief and Development. She read the article "Women and Agriculture" in EDN 134 and shared some insights about how to promote farming as a family business.

I really enjoyed the January *EDN* article on Women and Agriculture, and it resonated with my experiences. In particular, I liked what Angela Boss added at the end, about farming as a family. Working with the whole family is something that we at Episcopal Relief & Development have been trying to do more often when designing our programming with small farmers.

Figure 8. A family working together on their groundnut plot. *Source: Edward Nkwirize*

It is true that each family member typically has designated roles in the fields, gardens, at home, and at market. We are learning that working with those, rather than against them, or without knowledge of them, is really important. From this starting point, we can have discussions about how these roles could potentially be shifted.

In February I participated in an activity organized by Lutheran World Relief (LWR), as part of their Learning for Gender Integration initiative. I worked with a small team to evaluate a project they had recently completed in Uganda. The 'Namubuka' project ran from 2013 to 2016; it used a 'Farming as a Family Business' (FaaFb) approach to focus on gender issues in the communities, with the aim to improve overall family food security

Figure 9. A woman riding her bike to market, to sell a crop that her husband would have sold before. *Source: Fairuza Mutesi*

and incomes. The FaaFb methodology involved an intensive series of trainings and conversations over the course of the project. Together, husbands and wives learned about and discussed household gender roles; roles in agriculture; and general business concepts including household budgeting and marketing.

I did not get to see those training sessions, but I did see the results. For evaluation, we used a unique combination of PhotoVoice and Most Significant Change (two methodologies that go beyond the traditional survey; learn more about them from links found here), in a ten-day process. Participants shared, in their own words, what changed for them as a result of the project. Both project staff members and farmers confirmed that a lot had changed. Men and women showed us daily activity timelines that they had recorded both before and after the trainings. The differences were striking.

The biggest difference was that, after the FaaFb trainings and conversations, men were working with the women a lot more, both on agricultural tasks and on household chores (preparing dinner, fetching water, etc.). There were still activities deemed

Figure 10. Husband and wife working together to transport their cassava harvest. *Source: Janat Mutesi*

'men's' and 'women's', but there was more crossover, and the roles were based more on individual skills and strengths, rather than only on tradition.

The overall feedback from project participants was that things were better, both in terms of agricultural production and of family life. When we looked at some of the data from the broader project evaluation, we could see that it was true – for example, women's production of maize increased by 195% and their production of beans increased by 430%! Women increased their total income by an average of 125%. We enjoyed seeing the photos that the farmers took of the changes – everything from women using oxen and ploughs for the first time, to men getting their own bath water, to families sitting together to plan out budgets. Some of these are things that they never thought they would see – and neither did I.

As Angela said, communication and joint-decision-making are key. Some of the materials from the FaaFb project have helpful discussion guides that could be good starting points. My biggest takeaway is that neither men nor women can be considered in isolation when it comes to family farming. Even if it takes more time, working with families can lead to greater long-term positive change.

The site for LWR's Learning for Gender Integration initiative (LGI) at lwr.org/gender has links to LGI evaluation reports, the photobook, and a facilitation guide on combining the PhotoVoice and Most Significant Change methodologies.

Other helpful resources include the Farming as a Family Business Training Manual (FaaFB) and information about Gender Action Learning for Sustainability at Scale (GAL).

FROM ECHO'S SEED BANK

Are my seeds dry enough?

Salt jar method

By Stacy Reader and Tim Motis

Protecting the viability of seeds during storage can be a difficult task in the tropics, which often have high temperatures and high relative humidity. In May of 2017, ECHO hosted a seed saving workshop at our Global Farm in North Fort Myers, Florida. Both in preparation for and during this workshop, we encountered many helpful ideas related to appropriate seed storage. Dr. Tim Motis, Agriculture Technical and Research Director, will share them through upcoming Research Blog posts and *EDN* articles. One simple idea is the use of salt and jars to estimate seed moisture content.

Why seeds should be dry before storing them

Orthodox seeds (seeds that can enter a resting state prior to germination) must be dry prior to storage. Drying reduces seed moisture content, so that seeds will not rot or prematurely germinate in storage. Orthodox seeds should ideally be dried to between 3% and 7% moisture content for long-term storage; however, during rainy season(s), you may not be able to dry seeds below 10% moisture content, owing to high relative humidity levels. Several technologies are regularly used for detecting seed moisture content.

Ways to determine seed moisture

Moisture meters

Seed moisture meters can be helpful for organizations or groups that need frequent and/or precise seed moisture readings. The one shown in Figure 11 displays seed moisture content after heating a small sample of seeds. Other meters make use of the fact that electrical conductance varies with seed moisture. Moisture meters may be inappropriate and/or unaffordable for most farmers.

Oven drying

Seed moisture content can also be determined with an oven. Take a random sample of your seeds and obtain the fresh

Figure 11. Moisture meter used at ECHO in Florida. *Source: Tim Motis*

weight. Then, place the fresh seeds in the oven, wait for the temperature to reach 130°C, and maintain that temperature. Remove the sample from the oven after 4 hours (maize), 2 hours (other cereal crops), or 1 hour (other species). Allow seeds to cool, and then weigh them to obtain the dry weight. Use the following formula to calculate seed moisture content (as a %) (ISTA 2005).

$$\%\ moisture\ content = \frac{weight\ of\ fresh\ seeds - weight\ of\ dry\ seeds}{weight\ of\ fresh\ seeds}\ X\ 100$$

Drawbacks of this method are that the seed sample is destroyed, and that many small-scale farmers may not have access to an oven.

Bite and bend tests

Some simpler tests do not require expensive equipment. One common technique for determining if bean seeds are dry enough to store is to bite or press a fingernail into a seed. If no mark is left on the seed coat, the seed is most likely dry enough for storage. Seeds of cucurbit species can be tested by bending them; sufficiently dry seeds should not bend easily.

Salt-jar test

The salt-jar test is another simple option. This test is based on the fact that salt clumps at relative humidity levels of 70-75% (Sutcliffe and Adams 2014). Seed moisture content is affected by relative humidity. At 70-75% relative humidity, the moisture content of maize seed stabilizes close to 15% (Mrema 2011). See Table 1 for detailed steps.

Dr. Motis decided to test the salt jar method using maize seed, before sharing the technique at the seed saving workshop. We took maize seeds out of storage at ECHO's Global Seed Bank. Half of the seeds were soaked in water for one hour, then patted dry with a paper towel to remove all excess water on the seed coat. We left the other half of the seeds, which had been stored in an air-conditioned room, unaltered. We placed the subsamples of seeds (one that had soaked in water and one that had not) in identical jars and added one teaspoon of salt to each jar. We put the lids on, let the jars sit, then shook them to mix the seeds and salt. Figure 12 shows the two jars at the end of the trial.

Using a moisture meter, we checked the moisture content of the seeds in each jar. The maize seeds that caused the salt to stick to the sides of the jar had a moisture content of 16%, above the 15% threshold at which salt grains would be expected to begin clumping. Seeds that did not cause salt to stick to the jar had a moisture content of 11%, a level that would be acceptable for storing maize seed for over 6 months (see Table 1 in Part V of a Virginia Cooperative Extension document by Chappell *et al.* 2000).

The salt jar test seems to be an extremely useful and simple technique for estimating appropriate seed moisture content before storage. It has even been adapted for use with an empty soda bottle (The Organic Farmer 2015).

Figure 12. Salt jars with subsamples of maize seed; salt at bottom of jar indicates dry seed (left) and salt sticking to glass jar indicates wet seed (right). *Source: Tim Motis*

Table 1. Steps described by FAO and Kew Royal Botanical Gardens for using the salt-jar test to determine if seeds are dry enough for storage.

FAO (Mrema, 2011)	Kew (Sutcliffe and Adams, 2014)
• Add 1 teaspoon of salt to a dry jar or bottle. To make sure the jar is dry, put the lid on tightly and roll the jar with the salt inside. If the jar is dry, salt will not stick to the sides. • Now that you know the jar is dry, remove the lid and pour maize seeds into the jar [No specific amount/volume of kernels is given, but there needs to be enough empty space to shake the seeds and salt; the method to the right suggests filling half of a jar with seeds and salt.]. • Shake the jar and roll it gently for 2 to 3 minutes. • If the salt does not form lumps or stick to the sides of the jar, the moisture content of the maize seed is probably less than 15%.	• Mix a 1:1 ratio of salt and maize seeds. The seeds and salt together should fill half the volume of the jar. • Put the lid on the jar and leave it for 10 to 20 minutes. • Shake the jar gently. • If the salt falls to the bottom of the jar, the seeds are dry. If the salt sticks to the sides of the jar, the seeds need additional drying before being stored.

References

ISTA. 2005. *International Rules for Seed Testing*. Edition 2005. International Seed Testing Association, Bassersdorf, Switzerland.

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Chappell, G.F., D.A. Herbert, and S. McNeill. 2000. Part V: Seeds and Stored Grains. In: Agronomy Handbook. Virginia Cooperative Extension. Publication 59-67.

Sutcliffe, V. and J. Adams. 2014. Low-cost monitors of seed moisture status. Royal Botanic Gardens, Kew.

The Organic Farmer 2015. A simple way to test for moisture in maize. The magazine for sustainable agriculture in Kenya (an adaptation of the salt-jar test using an empty soda bottle).

BOOKS, WEB SITES AND OTHER RESOURCES

New epublication Releases: Crop Options to Improve Human Nutrition and Ways to Diversify the Smallholder Farm

ECHO is pleased to announce availability of the ebooks ***Crop Options to Improve Human Nutrition*** and ***Ways to Diversify the Smallholder Farm***. These electronic publications include the content from the fourth and fifth 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*).

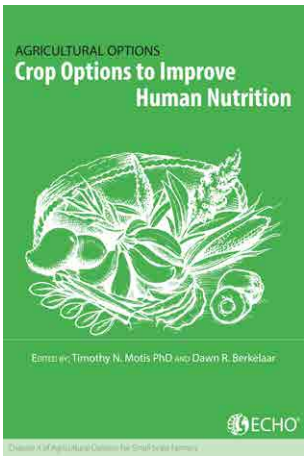
Crop Options to Improve Human Nutrition shares information about crops in various categories that have potential to improve human nutrition, including cereals, pulses, tropical fruits, roots, leafy greens and vegetables. The book shares important cultivation, processing and/or consumption details for some specific crops.

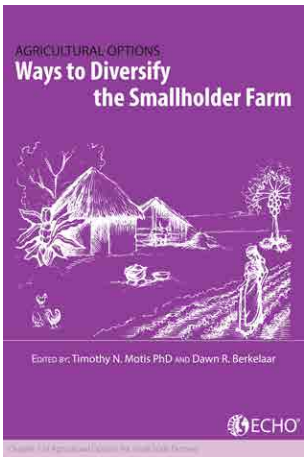
Ways to Diversify the Smallholder Farm emphasizes diversity and integration, and ties together many topics from previous chapters. It covers topics related to

agroforestry, incorporation of animals into farming systems, and fish farming.

Upcoming ebooks include the final three chapters of this series. These chapters cover practical, project-oriented options for coping with crop or animal pests (Chapter 6), seed saving and multiplication (Chapter 7) and understanding and coping with human health issues (Chapter 8).

The ebooks ***Crop Options to Improve Human Nutrition*** and ***Ways to Diversify the Smallholder Farm*** are available for purchase from Amazon in English, Spanish and French, for $4.99 each.





We hope that the perspective found in these ebooks will help lead to improved 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 Workshops

- An Introduction to Community Development
  August 14-18, 2017

24th Annual ECHO International Agriculture Conference

November 14-16, 2017
Crowne Plaza Hotel and ECHO Global Farm
Fort Myers, Florida
http://conference.echocommunity.org

Reminder about the Poster Session:
ECHO's 24th Conference in Florida will be our third time hosting a poster session. Follow the link(s) for information about preparing and printing a poster.
Poster Categories and Guidelines: http://edn.link/posterguidelines
Poster Submission Form: http://edn.link/posterform
Sample Poster: http://edn.link/sampleposter
Sample PowerPoint for Oral Poster Presentation: http://edn.link/sampleppt

Afternoon and Evening Workshop speakers needed! If you are interested in giving an hour long or 30 minute long talk during Conference, please reach out to rgill@echonet.org or apply online at: http://edn.link/presenteiac

This year's plenary speakers and their topics will be:

Putso Nyathi, Conservation Ag Technical Officer with Canadian Food Grains Bank, "An ex-post evaluation of 10 years of Conservation Agriculture promotion in Zimbabwe, lessons for food security interventions"

Dr. Johnathan Crane, Tropical Fruit Crop Specialist with University of Florida, "Tropical fruit production for small land holders"

Rachel Bezner Kern, Associate Professor with Cornell University, "Farmer-led research on agroecology and nutrition in Malawi and Tanzania"

Dr. Joshua Ringer, CEO of Indigdev LLC, "Post-conflict agriculture"

Kathy Bryson, International Training Director with SIFAT, "Integrating nutrition into agriculture"

Dan Gudahl, Executive Director with Whiterock Conservancy, "Cold Chain 101: You can't always get what you want"

Valentin Abe, Founder of Caribbean Harvest and Caribbean Harvest Foundation, "A new approach in aquaculture development in third world countries: The Haiti model"

Dr. Stephanie Velegol, Senior Lecturer of chemical engineering with Penn State, "Moringa-coated sand filters as a sustainable solution for clean water"

Dr. Tom Post, Regional Team Leader with World Renew: Asia, "Dialogue education and farmers"

ECHO's remaining 2017 training schedule will be posted at ECHOcommunity.org/events.

ECHO Asia Events:

ECHO Asia Agriculture and Community Development Conference
October 3-6, 2017
Location: Chiang Mai, Thailand

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!