# ECHO® Asia Notes

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## Farm-Generated Feed: Hog Feed Production

*by Keith Mikkelson, Executive Director, Aloha House, Puerto Princesa, Palawan, Philippines*

*[Ed (AB) note: Keith has practiced sustainable farming at the Aloha House Orphanage in Puerto Princesa for 15 years, producing nutritionally dense, farm-derived food that is consumed both at the orphanage and by local customers. Last May, I had the privilege of visiting Keith and his family at Aloha House, where the 2nd ECHO Asia Philippines Sustainable Food Production Workshop was held. I was impressed by what they are able to achieve in a small area, with very few off-farm inputs. Keith is continually generous and open in sharing his experience and knowledge with visitors and the broader ECHO network. In ECHO Asia Note 20, Keith shared about farm-generated fish feed. In this issue, Keith will share some basics for creating farm-generated hog feed.]*

### Introduction

Farm-generated fertility contributes to more sustainable agricultural systems. Crop residues and manures are part of the nutrient cycle and can lower input costs through the use of thermophilic composting, vermiculture, bokashi production, or green manures. Farm-generated feeds can also reduce expenses if farmers manage and utilize resources already available to them. For example, farmers might develop pasture using planned grazing for cattle; make hog feed from crop residue or dairy by-products (such as whey and skim milk); cultivate legume shrubs for cut-and-carry operations; and grow floating ferns and other water crops as feed supplements.

As densities of livestock increase, an industrious farmer finds ways and means to increase his farm's nutrient stream for the benefit of his system. This article will describe methods and techniques necessary for a smallholder farmer to succeed with farm-derived hog feeds. As you read, remember that a farmer should first fully exploit the extensive (and more passive) existing systems on the farm, and only then consider intensifying their overall operation (Figure 1).

*[Author's Note: It is important to note that many journals, papers, and guides caution against the tendency to abandon established methods of feed production for a more intensive system, without first assessing and then establishing new technologies with a transition period that is well-planned, capitalized, and realistic.]*

### Overview of the Aloha System

As we plan feed regimens for our pigs, we secure both on-farm and off-farm feed sources, in case of contingencies. This is important, but often overlooked. The advice from Skillicorn is noteworthy: "Most farmers do not maintain all the ingredients needed to prepare a complete feed on-site or the equipment to blend and pellet it. They must, therefore, have guaranteed primary and alternative market sources at all times, which is not a simple management activity" (Skillicorn, 1993). At the Aloha House, we purchase our fishmeal, rice bran, and copra meal from local sources. We also have a wide variety of legume shrubs, trees, and floating ferns to supplement

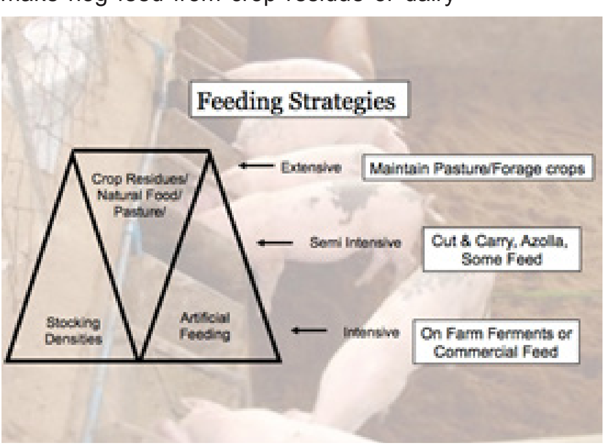


***Figure 1.*** *Feeding strategies.*

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any shortfalls in our purchased protein supply.

Our experience is with Landrace, Duroc, and Large White varieties, as well as other modern domestic breeds and crosses that respond well to intensive feed operations. These breeds experience consistent, rapid growth with our fermented feeds. Large White, Duroc and Land Race pigs are readily available from commercial growers and reliable back yard breeders, and they convert well to our system.

In our area of Palawan in the Philippines, native swine are an alternative to modern breeds. They are most economically raised on pasture with planted forage crops and tubers. In a pasture system, the primary challenges with these wild swine breeds are keeping them healthy and keeping them fenced affordably. Their powerful snout and rooting skills enable them to escape if they are not properly fenced. Rather than being pastured, local pigs are typically tethered. They often compete for table scraps with pets, tend to be stunted with poor growth, and can also be stressed by parasites (Figure 2). Internationally, basic established guidelines exist for swine raised in dirt lots, and tethering is not recommended. The University of Florida recommends 25 square meters per native swine (Meyer, 1993).

In the Philippines, both the Negros Warty Pig (*Sus cebifrons negrinus*) and the Palawan Bearded Pig (*Sus ahoenobarbus*) have been crossed with modern breeds with some success, but documentation of feed conversion and weight gain is hard to come by. Wild boar farmers in the UK cross pure wild boar males with domestic pig sows (usually Tamworths) to produce an increase in litter size, from an average of 5 in fully wild animals to 9 in hybrids. Hybrid vigor will contribute to better feed conversion, and hybrid pigs may benefit from fermented feeds. However, even with better feed conversion, increased costs may not justify the added carcass weight.

The remainder of this article will discuss methods for and benefits of lowering feed costs for modern pig breeds that tend to gain weight quickly and that are kept in a managed environment on cement or sawdust bedding. At the Aloha House, we have been using the “no-wash” happy pig protocol, as promoted through various Natural Farming networks. A complete description of the system is discussed in my book *A Natural Farming System for Sustainable Agriculture in the Tropics*. In this system, hogs are kept on a 1-meter deep sawdust bed and EM is added to the feed and water daily and sprayed weekly on bedding. Even sows enjoy farrowing on the deep beds and fermented feeds (Figures 3 & 4).

## Feed Sources

Many quality feed ingredients are available in most countries. Make sure you locate the best quality possible. Also, note that many feed programs in the industrial paradigm are not viable or profitable in developing countries!

### Choosing High-Quality Inputs

Corn-fed pork is a phenomenon that came about through a glut of low-cost maize production in industrialized countries. Modern corn has a higher carbohydrate level and a corresponding lower level of protein. By contrast, rice bran has twice the crude protein of corn, and is often less expensive. In a natural feed system, protein is the number one limiting factor in performance and growth of livestock; it is also the most expensive to purchase. If you keep the target protein level appropriate for the age of the animal, everything else will balance out with your natural feed. In creating your pig feed, you pay for protein. Old corn-based feed formulas are based on corn varieties that had more protein than the modern dent corn that permeates our supply chain (which also contains glyphosate residues and is often genetically modified). On Palawan, where Aloha House is located, corn is approximately twice the price and contains half the protein of rice bran, making corn protein four times more expensive than rice protein. We want natural feed supplies for our hogs to be economical and to assure the best end product.

### Unique Uses of Crops and Crop Residues Around the World

Innovative feeding solutions are found in various countries. Peanut tops, corn stalks, cabbage waste, and banana stalks are examples of useful agricultural byproducts used in the Philippines for hog feed production. Dried cassava is also used in Mindanao and Luzon islands. In Palawan, the large singular leaf of a wild aroid called *Amorphophallus paeoniifolius* is harvested from the understory of wetland forests and sliced or chopped for feed (Figure 5). In India, varieties of these aroids (called elephant foot yams) are grown for their edible tubers.

In Thailand, banana stalks are fermented for pig feed. Fresh sliced or shredded banana stalks are mixed with sugar and rock salt (at a ratio of 100 kg chopped stalks : 4 kg

*(Top to Bottom)* ***Figure 2.*** *Tethered wild hogs like the Sus ahoenobarbus (Palawan Bearded Pig) in Palawan, Philippines, rarely thrive under domestic conditions.* ***Figure 3.*** *Happy Pigs on EM inoculated sawdust bedding.* ***Figure 4.*** *Farrowing is accomplished on high quality farm derived feeds and the addition of finely crushed livestock lime.* ***Figure 5.*** *Amorphophallus palawanasis - Elephant foot yam in Palawan, Philippines.*

sugar : 1 kg rock salt) and fermented for three days in a bucket. Various naturally-occurring cultured microorganisms are added to enhance the fermentation process. After three days, the fermented produce is mixed with an equal amount by weight of high-protein brans and fish meal (Tancho, 2015). *[Eds.' Note: For further reference and details on these natural farming pig feed recipes, please see Dr. Arnat Tancho's "Natural Farming" and "Natural Farming Cartoon" books, which are available in English, Thai, and Khmer at the ECHO Asia Office.]*

In Kenya, sweet potato vines are a valuable byproduct for livestock. Vines are chopped and fermented with EM1. Additional corn meal and protein are added to enhance performance (The Organic Farmer, 2015).

## Cut and Carry Legumes and Grasses

Grasses can be an important forage source for animals. According to Dr. Martin "about 75% of forage consumed in the tropics is grass" (Martin, 1993). At the Aloha House, we grow a biodiverse spectrum of fodder crops that we bring to our hogs as cut and carry (Figure 6; Table 1). Compared to rooting livestock, people are better able to harvest carefully and leave plants intact. We grow *Chrysopogon zizanioides* (Vetiver) for slope stabilization and swale management in our water harvesting system. We also use it as a forage; we can harvest the young Vetiver with some frequency during the rainy season and maintain forage nutritional value. We have also utilized fresh cut *Pennisetum purpureum* (Napier) as a forage for hogs and cattle.

At the Aloha House, we have utilized the Sloping Agricultural Land Technology (SALT) system since 2001. This system uses legume tree and shrub perennials to stabilize soil along hillside contours, also incorporating annual alley crops. The fermentable legumes are important sources of protein and vitamins, as well as enzymes that boost feed digestibility (Watson, 1985). Over the years, we have been able to save seed from these prolific producers and expand from our starting stocks. We have established stands and contours of *Desmodium rensonii* (Local name: Ticktrefoil), *Flemingia congesta* (Malabalatong), *Indigofera*, *Gliricidia sepium* (Kakawate or Madre de Cacao), *Leucaena leucocephala* (Ipil-Ipil), and *Mangium acacia*. All of these legume species are valuable for fermented feeds (Agroforestry.org, 2008).

***Table 1.*** *Potential of cut and carry grasses - Chrysopogon zizanioides (vetiver) (Wikipedia).*

| | Young Vetiver | Mature Vetiver | Old Vetiver |
|---|---|---|---|
| Energy [kcal/kg] | 522 | 706 | 969 |
| Digestibility [%] | 51 | 50 | - |
| Protein [%] | 13.1 | 7.93 | 6.66 |
| Fat [%] | 3.05 | 1.30 | 1.40 |

***Figure 6.*** *Cut & Carry - readily consuming young vetiver grass.*

## Fermenting Greens

Crop residues can be used to lower feed costs. At Aloha House, legumes such as peanut tops, *Gliricidia sepium*, *Leucaena leucocephala*, *Flemingia congesta*, *Desmodium rensonii*, and *Pueraria lobata* (Kudzu) have been used successfully. Moringa and floating ferns are also used. Within the Korean Natural Farming (KNF) network, certain additives are avoided in hog feed due to alleged detrimental effects. We apply the KNF hog system at Aloha House, and therefore do not use bean vines or cassava leaves because of reports of bad side effects. The side effects are not well documented, but we avoid these as a precaution, and we have many alternatives. The protocol for introducing a new ingredient in a formula is to go slow and add one new ingredient at a time, to be able to tell which ingredient is having what effect. Be on guard for ill effects. Track weight gain and compare with normal growth. If scouring (diarrhea) occurs, remove the experimental ingredient and return to proven feed components.

## Sourcing Mill Byproducts

To create a successful feed mix for your pigs, you must properly source high quality inputs, most often from local mills. "D1" rice bran (explained in more detail below) is considered the premium grade for livestock. Other lesser grades (D2 to D4) should be avoided, because protein content is lower and the percent of indigestible fibers (i.e. cellulose) is higher. See the Rice Mill Primer in the notes section of my book for more information (Mikkelson, 2005). Other brans (corn, wheat, etc.) can be used, but beware of compromising crude protein levels. Top quality rice bran is 12% to 14% crude protein, while most modern corn varieties contain only half this amount of crude protein.

Copra meal is the by-product of coconut fat extraction and can be obtained at oil mills. Copra meal contains up to 24% crude protein, but it should be limited to 10% of your formula by weight. It contains good quality protein but also a high amount of fat (similar to Black Soldier Fly larvae). Too much fat in the diet can cause scouring (diarrhea), and it will also sacrifice weight gain by reducing consumption of carbohydrates and protein. Copra meal is still worth including in our formula at 10% maximum by weight, because in our area it has a favorable price point. Fermentation (discussed below) further boosts digestible protein of copra meal. If copra meal is not available, increase the amount of fish meal used.

## Rice Mill Challenges

Large Cono Mills are able to produce highly polished rice (often labeled "WMR" for Well Milled Rice), leaving a waste byproduct that is valuable for feed formulation (Figure 7). Compared with other rice byproducts, this D1 rice bran has the highest vitamin, mineral and protein content.

In many areas, only small mills (sometimes called "Satake Mills") are available. These mills do not highly polish their rice, and may

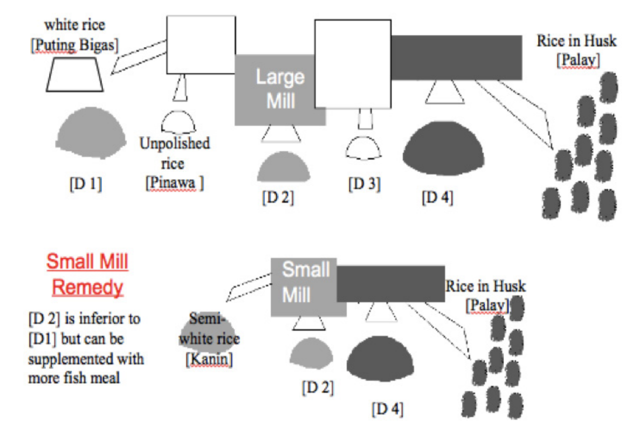



***Figure 7.*** *Rice mill primer (Mikkleson, 2005).*

label it "RMR" (Regular Milled Rice). Satake Mills produce only D2 rice bran; it is inferior to D1 bran, but can be used in the Aloha House formula if it is supplemented at an increased rate of 25% more fishmeal than the basic formula by weight.

### Floating Ferns

Many floating ferns and aquatic plants are high in protein. Aquatic plants can grow well in ponds that have adequate fertility to support them. They can be utilized for hog feed and are excellent as a cost-saving supplement when expensive purchased feeds are used. Floating ferns such as *Azolla* spp., duckweed (various genera and species), and even *Salvinia* spp. can be utilized if they are cultured and harvested efficiently. Omnivores such as swine and poultry readily eat large quantities of these greens as a feed source. Options for production include separate dedicated ponds, containers or troughs, and net-protected rafts within the fish culture. Remember, any fodder crops grown within the fishpond must be protected or isolated from the fish; otherwise the fish will overgraze and deplete the crop (Figure 8)! In addition, if one goal of the pond is algae production, plants growing on the surface will block sunlight and prevent growth of algae and other phytoplankton. It is difficult to produce both protein sources (i.e. algae and water plants) to their full potential in the same column of water.

In experimental trials in India that compared *Lemna minor* (common duckweed), *Ipomoea reptans* (kang kong or morning glory), *Trapa natans* (water caltrap), and *Salvinia cucullata* (often mistaken for Azolla), both duckweed and morning glory had good feed conversion ratios and high

***Figure 8.*** *Azolla and salvinia production at Aloha House.*

protein: 28% and 32% respectively. (Kalita, 2007). Both of these can be great fodder crops. Azolla (*Azolla caroliniana*), with a reported protein range of 19-30%, is another fast-growing floating fern that I wish had been included in the India study.

Be careful not to overharvest these crops, or production will not be sustainable. As a general rule of thumb (under ideal conditions), you should harvest no more than half of the floating biomass per week (or 1/7 of the total biomass per day). The trick is to keep the plant in the rapid vegetative stage, so you will have to monitor which method of harvest is more productive in your system. Azolla tolerates moving water better than duckweed. Salvinia grows the fastest, but can be very invasive.

### Pelletized Feeds

If you seek to intensify hog production, use of concentrated feeds is worth considering. However, commercial feeds are very expensive. The ECHO Technical Note on fish farming (Murnyak, 2010) lists a variety of supplemental feeds that are commonly used: rice bran, mill sweepings, termites, table scraps, maize bran, and many green leaves (Murnyak, 2010). Pelletized feeds are not necessary, despite marketers that portray pellets as more "modern" or "scientific." The added cost of management and labor to make pelletized feeds outweigh the gains in growth. Hogs will readily consume a mash or crumbled fermented feed with great interest.

### Documented Problems with Soy and GMO Crops

Aloha House is a soybean-free operation due to the detrimental health effects of soy. The phytoestrogens and enzyme inhibitors of soy are problematic for both livestock and humans. Concerns documented with soy include the following:

- High levels of phytic acid in soy reduce a body's assimilation of calcium, magnesium, copper, iron, and zinc. Phytic acid in soy is not neutralized by traditional preparation methods such as soaking, sprouting, and long, slow cooking. Diets high in phytic acid have caused growth problems in children.
- Trypsin inhibitors in soy interfere with protein digestion and may cause pancreatic disorders. In test animals, consumption of soy containing trypsin inhibitors resulted in stunted growth.
- Soy phytoestrogens (i.e. plant estrogens) disrupt endocrine function, and can potentially cause infertility and promote breast cancer in adult women.
- Soy phytoestrogens are potent anti-thyroid agents that cause hypothyroidism and may cause thyroid cancer. In infants, consumption of soy formula has been linked to autoimmune thyroid disease.
- Vitamin B12 analogs in soy are not absorbed, and actually increase the body's requirement for B12.

(Nienhiser, 2003)

*[Eds.' Note: See the "Soy References Cited" section for more information.]*

GMOs (genetically modified organisms) are also potentially problematic. A recent study linked cancer in hogs to their consumption of GMO soy and maize (Carman, n.d.). With so many other crops to choose from, we have chosen to avoid GMOs at the Aloha House.

## On-Farm Production of Hog Feed & Formulas

With experimentation and careful record-keeping, hog farmers can produce their own high-quality feed. In many countries, farmers can purchase readily available ingredients for production of cost-saving feeds. However, farm-generated ingredients make hog feed even more economical! At Aloha House, two people can produce 200 kg of moist feed in less than an hour.

### Benefits of Fermentation

The fermenting activity of certain beneficial microorganisms during the production process can enhance digestibility and shelf life of hog feeds. According to one study, the use of microorganisms increased the crude protein in copra meal from 17.24% to 31.22%. The amino acid profile was also found to be greatly improved (Cruz, 1997).

*[Author's Note: In addition to hog feed, at Aloha House we also ferment our feed for chickens, ducks, and fish with the help of diverse probiotic groups of microbes. However, we do not use fermentation for our ruminant feeds (this will be covered in another upcoming AN).]*

When fermenting your feed, be sure to use proven strains that are not cross-contaminated with wild pathogens. We use EM-1, a commercial product that undergoes laboratory testing and is approved for livestock and aquaculture by the Department of Agriculture and by the Bureau of Fisheries and Aquatic Resources in the Philippines. EM-1 was formulated by Dr. Teruo Higa in Ryukyus University, Okinawa, Japan, and is readily available in over 100 countries. Thailand now consumes more EM-1 than Japan.

EM-1 contains cultures of robust lacto-bacilli, photosynthetic bacteria, beneficial yeast, and more. The microorganisms feed on sugars and other carbohydrates, while creating secondary metabolites that increase the nutrient range of the feed. The probiotic value is very high. My book, *A Natural Farming System for Sustainable Agriculture in the Tropics*, is a user's guide to EM technology. It is available online as a free PDF download or can be obtained through the ECHO bookstore.

If EM-1 is not available, try using cheese whey or yogurt whey, sourced from a local creamery. Start small by substituting the whey at the same rate as EM-1 in the formula below, and add more in subsequent batches if it did not have an effect. Good fermentation should create a sweet and sour smell after two weeks. If foul odors such as rotten eggs (sulfides) or black molds occur, do not feed it to your hogs. Instead, add your small failed experimental batch to the compost heap and use it as fertilizer.

Another alternative to EM-1 is to use indigenous microorganisms (IMOs). In the KNF (Korean Natural Farming) system, "materials are mixed with sugar, salt, and IMO solution." *[Eds.' Note: For more information on the creation and use of IMOs, please see the presentation "An Introduction to Asian Natural Farming" on ECHOcommunity.org.]*

***Figure 9.*** *Filippino farmers packing inoculated EM feed into airtight food grade containers. It will be ready after it ferments for two weeks.*

### Beginning Formula

Table 2 below is a good recipe starting point for creating your own feed. Be sure to keep notes and adjust the ingredients based on your available feedstock and the performance of your farm-made feeds! Costs listed are relevant for our location and might differ elsewhere.

### Mixing Sequence and Moisture Content

Make sure you have a clean, smooth concrete surface for mixing your feeds. When we ferment hog feed, first we pre-mix all our dry materials (rice bran, copra meal, etc.). Then we mix in the greens (e.g. salvinia, azolla, and legumes) and crop residues, so that the dry material coats the moist greens. Next we add 100 ml. each of EM-1 and molasses, diluted in 10 liters of water. We want the moisture content of the mixture to be between 30 and 50%; you may need to add additional water to reach this target moisture range.

A simple field test for moisture content in the 30-50% range is the "Ball Test." Take a portion of the feed in two hands and form a ball with mild pressure. If it sticks together without dripping, it is in the target range. Congratulations! If the ball does not stick together, the mixture is too dry. Carefully add water a little at a time and test again. If it is dripping wet, it is over the moisture target range and you need to add additional formula-balanced dry materials to lessen moisture. Do not just add rice bran as a drying agent because you will compromise the recipe and it will not perform well.

After completely mixing all ingredients to 30-50% moisture content, we compress it in airtight pails and ferment for two weeks (Figure 9). This will ensure more uniform moisture content of the materials and achieve a better end product than a fresh feed mix.

***Table 2.*** *Hog starter feed (weaning to 18 kg.).*

| Item | Crude Protein | Weight (Kg) | Cost USD/ Kg | Crude Protein Units* | Cost USD |
|---|---|---|---|---|---|
| D1 Rice Bran | 14% | 50.00 | 0.30 | 7.00 | 15.00 |
| Copra Meal | 22% | 7.50 | 0.23 | 1.65 | 1.73 |
| Fish Meal | 47% | 6.00 | 0.95 | 2.82 | 5.70 |
| Floating Ferns/Legumes | 15% | 4.00 | 0.00 | 0.60 | 0.00 |
| Livestock Lime | 0% | 0.10 | 0.20 | 0.00 | 0.02 |
| Rock Dust Minerals | 0% | 0.20 | 0.05 | 0.00 | 0.01 |
| Charcoal - Fine | 0% | 0.20 | 0.03 | 0.00 | 0.01 |
| Fish Silage (FAA) | 29% | 2.00 | 0.15 | 0.58 | 0.30 |
| EM & Molasses | 100 ml ea. | 0.20 | 0.20 | 0.00 | 0.04 |
| | | 70.20 | | 12.65 | 22.81 |

**"Crude Protein Units" refers to the crude protein (%) in kilograms (item weight x CP%)*

## Formulas for Modern Hogs

When creating your feed, be sure to measure and weigh each component accurately and record the performance of each trial mix. Keep some of your hogs on the current feed system (as an experimental control) so you have something with which to compare. After one month, compare the weight of hogs with your new feed and with the control.

We encourage you to use ingredients that are available in your area. Learn to optimize your own blend based on regular testing. A spreadsheet is useful for adjusting inputs and formulating feeds. After many months of record keeping, you will be able to evaluate the benefits of your farm-generated feeds. Crude protein is a good starting point; we find that if we formulate our mix based on crude protein, the rest takes care of itself.

Earlier I discussed floating ferns and their use as a fresh feed or for fermenting. Floating ferns are good for biodiversity and can create a broader range of inputs. You can use a combination of duckweed, azolla, and salvinia as a component of your low-cost, high-quality hog feed. Learn to culture these ingredients. Purchasing them is very expensive! Spirulina (a cyanobacterium, also known as blue-green algae) is a possible alternative to floating ferns. Over 30% of worldwide spirulina production goes to non-human feed stuffs (Belay, 1996). Other substitutions have been explored with mixed results, including water hyacinth in Nigeria (Igbinosun, 1988). I have not experimented with water hyacinth and would not recommend it due to its poor results in this study, but if you do, please send us your results!

## Vitamins and Minerals

Finely crushed rock powder from gravel mills will have a range of minerals to supplement any deficiencies in cut greens or floating ferns (Murnyak, 2010). If we do not have rock powder, we add our organically grown moringa at 1% by weight of the mixture.

***Table 3.*** *Hog starter feed cost comparison*

| Item | Crude Protein | USD / 50 Kg Sack | USD / Kilo |
|---|---|---|---|
| Commercial Feed | 18.00% | 35.00 | 0.70 |
| Hog starter feed (Table 2) | 18.02% | 16.21 | 0.32 |

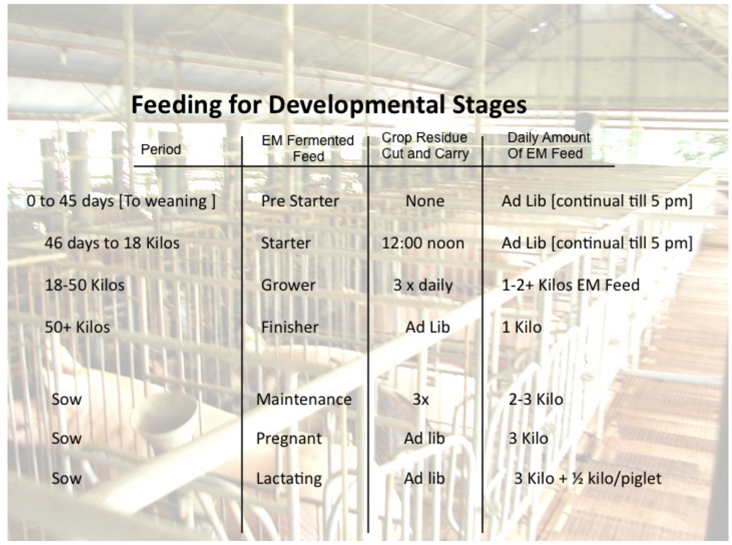
Finely ground livestock-grade limestone from an agricultural supplier of feed store can also be added for bone growth support and lactating sows.

## Hog Feeding Schedule and Protein Adjustments

Protein is the expensive part of an intensive feed operation, and you should not use more than you need. If fresh greens are not used as cut and carry, then follow a protein reduction schedule based on the developmental stage of the hog in order to use less of the more expensive feed (Table 4). We follow well-established swine nutrition guidelines from the University of Missouri (Rea, 1993). Hogs need different amounts of protein depending on their stage of growth. To minimize costs, be sure to remove your most expensive protein as levels are adjusted. In our case, fishmeal costs the most and is what we would reduce based on our animals' developmental requirements. Starter feed (Table 2) is used from weaning to 18 kg, and contains 18% protein (Table 3). This high protein feed prevents stunting in the early stages. Protein is reduced to 16% for hogs in the "Grower Stage" (18-50 kg); we reduce fishmeal by three kg in this stage. To further economize production, hogs in the "Finishing Stage" (50 kg. to harvest) require only 14% crude protein. Finisher feed can be adjusted by reducing fishmeal by two more kg in our formula. All other ingredients remain the same. Greater savings and better animal health can be obtained with on-farm production of fermented hog feed, compared to commercial feed (Table 2).

At Aloha House we choose to maintain the starter ration throughout the life of our hogs and reduce overall protein by increasing the amount of vegetative feed that we offer. Figure 11 outlines the schedule for developmental stages of swine used on our farm. Weaners do not participate in cut and carry. As hogs mature, they are fed more "free food" from the farm in the form of crop residue and cut and carry.

***Table 4.*** *Schedule for using fermented feed with crop residues ("Ad lib" means that feed is continually available to the pig). (Source: http://www.slideshare.net/mik1999/sustainable-livestock-1-cattle-and-hogs)*


Feeding for Developmental Stages

| Period | EM Fermented Feed | Crop Residue Cut and Carry | Daily Amount Of EM Feed |
|---|---|---|---|
| 0 to 45 days [To weaning ] | Pre Starter | None | Ad Lib [continual till 5 pm] |
| 46 days to 18 Kilos | Starter | 12:00 noon | Ad Lib [continual till 5 pm] |
| 18-50 Kilos | Grower | 3 x daily | 1-2+ Kilos EM Feed |
| 50+ Kilos | Finisher | Ad Lib | 1 Kilo |
| Sow | Maintenance | 3x | 2-3 Kilo |
| Sow | Pregnant | Ad lib | 3 Kilo |
| Sow | Lactating | Ad lib | 3 Kilo + ½ kilo/piglet |

## Conclusion

Small-scale hog feed production can be managed by the careful use of locally grown and farm-generated inputs. Planning production two weeks in advance will assure a steady supply of nutritious fermented feeds. If you supply yourself with high quality inputs through efficient production and harvesting, and produce your own feeds, you will have more profits due to less capital input.

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# Bringing Balance and Caution to Tropical Forage Crops

*by David S. Price*

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I read with great interest Stuart Brown's recent article in ECHO Asia Notes #23 entitled *The Use of Tropical Forages for Livelihood Improvement in Southeast Asia: A Focus on Livestock* (Brown 2015). Mr. Brown is an experienced agricultural consultant most recently working in Cambodia. In the article, he introduced some grass and legume forages (forages are "plant material grazed or fed to livestock") and recommended them for increased utilization by rural smallholders in parts of Southeast Asia.

As I continued reading, however, I became increasingly uneasy with Mr. Brown's recommendations. Most of the taxa recommended in the article are serious invasive species, and (I believe) should not be introduced into new areas without extensive evaluations of the possible impacts. In this response article, I will briefly share my experience with invasives, provide an overview of the invasive species issue, show what experts say about the grasses and legumes recommended by Brown, and attempt to offer some guidelines and suggestions for less potentially harmful outcomes.

I am a New Zealander by birth, which impacts my views of invasive species. New Zealand is probably inflicted with a greater number of harmful invasive alien organisms than anywhere else on Earth. Infamously, in their goal to make New Zealand just like 'the Old Country' (Britain) and to remedy what they saw as a depauperate native flora and fauna, my country's founders introduced an impressive range of plants and animals—several deer species from North America, Europe and Asia; chamois and tahr from Eurasia; possums from Australia; peafowl from Asia; and so forth. Rabbits were introduced for hunting and promptly became a major instrument for land degradation and erosion, so we introduced stoats, weasels and ferrets to 'control' them (the mustelids found an easier living hunting native birds, driving many to extinction). Introduction of exotic species was not limited to animals; the New Zealand native forests were also quickly converted to pastoral land where introduced species now dominate. Gorse was introduced for hedgerows and Scotch Broom as an ornamental, both of which now cover vast areas in monoculture and which have defied decades of efforts to control them. Over 25,000 plant species were introduced (Duncan & Williams 2002)—compared with New Zealand's roughly 7,000 native species—and over 2,500 became naturalized in the wild, with more than 300 being classed as invasive species.

My long experience in Indonesia has also allowed me to observe firsthand the introduction of a range of invasive alien species, both plants and animals. My background as an ecologist and naturalist has afforded me some insights into these species' behavior and impacts, and into the resulting costs and benefits.

## Invasive Alien Species

> *"Invasive alien species are emerging as one of the major threats to sustainable development, on a par with global warming and the destruction of life-support systems."*
>
> Preston and Williams (2003)

Invasive alien species (often IAS in the literature) are those species introduced to an area outside their normal or native range, either purposefully or by accident, whose colonization causes significant harm. The species may become weeds, pests or pathogens, affecting both human interests and natural systems, and impacting agricultural systems, native ecosystems, biological diversity, or human well-being (Perrings *et al.* 2002; UNEP; CBD). Well-known examples of invasive alien species include kudzu in the United States, water hyacinth throughout the tropics, zebra mussels in the Great Lakes, and European starlings in North America.

Introduced species are not all bad; in fact, civilization would be impossible without them. Approximately 98% of the U.S. food system, valued at USD 800 billion annually, comes from introduced species such as wheat, rice, corn, and various livestock (Pimentel *et al.* 2001:1; Pimentel *et al.* 2005:273). Many naturalized species (non-natives forming sustainable populations without further human facilitations) do not become invasive (Rejmanek 2000:497), and even some that are invasive may ultimately be beneficial. However, a significant number do become harmful invasives. In Europe, 11% of over 10,000 non-native plant populations are thus far known to cause measurable ecological impacts (Vilà *et al.* 2010).

Alien species invasions are recognized as one of the most significant and pervasive drivers of global environmental change (McNeely *et al.* 2001; Simberloff *et al.* 2013) (Table 1). The Millennium Ecosystem Assessment (2005:96-99) lists invasive species as one of the five top drivers of biodiversity loss. In the United States, 42% of the officially recognized threatened or endangered species are at risk primarily due to threats from invasive alien species (Pimentel *et al.* 2005). Of the almost 700 documented animal species extinctions, over 20% were caused by invasive species (Clavero & García-Berthou 2005). Fifty-six of the world's 100 most serious invasive

***Table 1.*** *Common actions & impacts of invasive species (after Bradshaw et al. 2009)*

| Action of Invasive Species | Impacts of Invasive Species |
|---|---|
| Cause extinctions of native biota | Threaten biodiversity |
| Alter abiotic environments | Change soil structure, nutrient cycles, hydrology, fire regimes |
| Simplify ecosystems | Threaten delivery of important ecosystem goods and services |
| Become agricultural weeds | Increase competition with crops, degrading land |
| Harm humans and crops | Introduce or facilitate transmission of virulent diseases of humans and crops |

species are found in the tropics (ISSG 2007), and Asia is a hotspot. Stephen Elliott of Chiang Mai's Forest Restoration Research Unit (FORRU) says that one of the biggest hindrances to ecological restoration of tropical forests is invasive species that outcompete and smother native tree seedlings and that modify fire regimes (personal comment).

The socioeconomic costs of invasive species are measured in terms of unemployment, damaged goods/equipment, power failures, food and water shortages, environmental degradation, loss of biodiversity, increased rates and severity of natural disasters, disease epidemics, and lost lives. It is notoriously difficult to assign monetary equivalents to such impacts. However, Pimentel and colleagues (2000) have (conservatively) estimated that "invasion of alien species costs the United States more than USD 100 billion annually," and over USD 315 billion globally per year (Pimentel *et al.* 2001). Globally, agricultural losses are estimated to be between USD 55 and 250 billion a year (Bright 1999). Even single species can be responsible for losses running in the millions of dollars. The Latin American golden apple snail, *Pomacea canaliculata*, was introduced into the Philippines in the 1980s to provide a 'high protein food source' and has subsequently caused losses to rice crops in the order of USD 1 billion annually (Naylor 1996). Mainland China currently has at least 400 invasive species which cost the country an estimated USD 14.5 billion annually (Agoramoorthy & Hsu 2007).

Some large-scale, far-reaching impacts of invasion are not readily detectable, such as the multiple impacts by introduced nitrogen-fixing plants on ecosystem functions (Vitousek *et al.* 1987). Ecosystems may be modified below- and above-ground by introduced plants that transform ecosystem structure and function, especially through community composition and altered nutrient cycling (Simberloff *et al.* 2013). Soil chemistry, hydrology, and fire regimes can be altered (Cronk & Fuller 1995). Erosion regimes can be changed and physical structures (e.g. dunes) can be added (Simberloff 2011). A common impact is general land degradation, one of the foremost drivers of poverty (Kaimowitz & Sheil 2007).

The consequences of invasion may take years or decades to be identified, and invading plant species may not 'break out' until many years after naturalization (Essl *et al.* 2011). In Florida, Brazilian pepper remained very restricted in range for a century, but then rapidly expanded across a wide area (Crooks 2011). Some problematic plants introduced to Europe have taken between 150 and 400 years to reach their fullest areal extent (Gassó *et al.* 2010), underscoring the extent to which humans do not know the consequences of species introductions.

The invasives problem is so great and universal in extent that we have even coined a term for its inevitable (without our intervention) outcome. 'Homogenization' is the process in which ecological communities and ecosystems become increasingly dominated by a small number of widespread, human-adapted species (Millennium Ecosystem Assessment 2005:79.) Homogenization describes the way such invasions and introductions are transforming ecosystems to simpler, less productive states and diverse communities to simple ones with vast numbers of few species. The end results are novel ecosystems which provide fewer of the goods and services that humans need to live and thrive. This is now rapidly occurring in every place on Earth.

> *"The litany of negative, far-reaching impacts of invasions suggests that proposed introductions warrant great caution."*
>
> (Simberloff *et al.* 2013)

What gives a particular species the propensity towards invasiveness? Invasive species have characteristics or traits that give them significant competitive advantage over existing native species, or increased ability to colonize marginal, disturbed habitats. These traits include the ability to reproduce, grow and disperse rapidly; aggressive competition for resources such as water, nutrients, and space; and lack of natural enemies in their new environment. Invasive species are often pioneer species, and tend to be generalists in terms of requirements.

## Connections with Fodder Crops

The goal of developing new pasture plants is the sustainable intensification of agriculture. Invasive species are a serious barrier to this goal because they increase the environmental and economic costs of food production (Driscoll & Catford 2014). Enormous effort is put into developing new varieties that will facilitate the goal, but agriculturalists and extension workers invest very little thought and even less money in order to determine invasion risk (Driscoll *et al.* 2014). Environmental risk assessments are rarely carried out, partly because the corporations and organizations that develop them bear no legal or financial responsibility for the costs when such plants become invasive burdens (Driscoll *et al.* 2014).

Most research conducted on the invasion risk of new pasture plants is carried out by the environmental and conservation science communities. The findings are stunning—new pasture crops show an overwhelming propensity to become seriously invasive. Over 90% of new pasture species developed by agribusiness become invasive weeds (Driscoll & Catford 2014). The characteristics that are selected for—fast growth, efficient reproduction and dispersal, and tolerance of broad environmental conditions—are the very traits that make such plants invasive (ibid). Processes like hybridization and allopolyploidy (how we got wheat) increase an organism's genetic diversity and enhance its capacity to flourish across a broad range of conditions (Driscoll *et al.* 2014). New crop species may interbreed with existing weed species, intensifying invasive tendencies. Invasiveness is often recognized as an important trait in successful novel pasture crops—they should be able to survive and spread unassisted (Miller *et al.* 1997).

## Review of Forage Crops Recommended by Brown

Many useful online resources provide information on various species that are known or suspected to be invasive in different countries. At least one site rates plants for risk: less than 1 = low risk, free to import; greater than 6 = high risk, reject; between 1 and 6 = requires further evaluation, proceed with caution.

- Global Invasive Species Database (GISD) http://www.issg.org/database/welcome/
- Pacific Island Ecosystems at Risk (PIER) http://www.hear.org/pier/index.html
- CABI Invasive Species Compendium (CABI) http://www.cabi.org/isc/
- IUCN Species Survival Commission Invasive Species Specialist Group http://www.issg.org/
- Island Biodiversity and Invasive Species http://ibis.fos.auckland.ac.nz/
- Tropical Forages (TF) http://www.tropicalforages.info/index.htm also lists possible invasion tendencies

The following are brief statements regarding the invasiveness or potential invasiveness of the species listed in Brown's article.

Where taxonomy differs or is in confusion I have deferred to the Integrated Taxonomic Information System (http://www.itis.gov/) as the authority.

### *Megathyrsus maximus* (syn. *Urochloa maxima*, P*anicum maximum*): Guinea Grass

GISD: "... has become prevalent in Samoa and Tonga ... a problem species in Guam and Hawaii ... can form dense stands and displace native species ... forms dense stands in open pastures and disturbed areas … can suppress or displace local plants on fertile soils in pastures ... resistance to drought also means it builds up a dangerous mass of plant material so when fires occur, the blaze is fiercer and native plants which have not built up fire-tolerance are wiped out ... can survive fires [so] can dominate the ground after a fire ... can tolerate brackish water and interfere with stream flow due to its highly aggressive invasive habit."

PIER: gives the species a 6, meaning 'high risk' and 'reject.' "A serious weed in tropical and subtropical crops and wastelands. Very common in open disturbed areas of forests, wastelands, and roadsides...in mesic to humid lowlands. Grows into tall, dense stands, displacing natives, a fire hazard in dry periods. In Hawaii, naturalized and common, 0-850 m ... in Fiji, a weed of sugarcane fields, roadsides, and river banks ... in Australia, ... forms dense stands that may exclude some native species, particularly some early flowering grasses ... in New Caledonia, now widely dispersed."

CABI: "a highly successful invader in tropical and warm temperate areas after introduction as fodder. It can spread from seed, is highly competitive with native flora, and while it is highly fire resistant it can quickly spread to invade gaps left in natural vegetation after fire."

TF: "a very effective colonizer in ungrazed areas, particularly where some form of soil disturbance has occurred ... spreads along water courses and ungrazed roadsides, and has been listed as a weed in many countries ... a major weed in sugarcane fields, due to its ability to grow under shaded conditions. ..."

### *Brachiaria* species hybrid (cv. Mulato II; Cayman)

Closely related to the above species. I am unable to find invasive information on this taxa, however, from the TF site: "Likely to be similar to *B. brizantha* [a synonym of *Urochloa brizantha*], having potential to colonize disturbed areas." PIER gives the genus rating 4—requires further evaluation.

### *Paspalum atratum*

At least three other *Paspalum* species have significant impact as invasive species and are listed as noxious weeds somewhere. There appears to be taxonomic confusion between this species and *P. plicatulum*, a low-risk invasive species, at least in New Caledonia and Cuba. Another, *P. paspaloides* or knotgrass, is invasive in Europe (DAISIE 2009). Caution is warranted. Vetiver grass (*Chrysopogon zizanioides*), a non-invasive native of India, should be considered a superior alternative on the grounds that it is sterile and less competitive with native plants. Both have similar forage values and limitations (only young leaves are palatable), but vetiver grass has many additional characteristics that make it useful for addressing a wide range of agricultural and sustainability issues.

### *Pennisetum purpureum*: Elephant Grass, or Napier Grass

This species is classed as 'invasive' in so many countries that it should NOT be promoted in any way. It may become one of the most serious weeds that Southeast Asia will have to deal with during the next thirty years or so. PIER gives it extremely high ratings for invasiveness and risk.

PIER: "A major problem in the Galápagos Islands. One of the most invasive weeds in Papua New Guinea ... subject to an eradication program on Mangaia ... planting of this species prohibited in Miami-Dade County, Florida (U.S.) ... Not-withstanding its value as forage, elephant grass has become one of the worst weeds in the tropics because of the difficulty of controlling it in croplands and fallow areas."

CABI: ... "*P. purpureum* is considered one of the most successful invasive grasses in the world. ... included in the Global Compendium of Weeds where it is listed as an agricultural and environmental weed as well as an invasive species ... an aggressive grass that grows rapidly, colonizing new areas and forming dense thickets. Once established, it can change features of ecosystem functions by altering fire regimes, hydrology cycles, biophysical dynamics, nutrient cycles, and community composition ... well adapted to drought conditions and can also dominate fire-adapted grassland communities ... has the capability to resprout easily from small rhizomes left after disturbance, resulting in the out-competing and smothering of native plant communities."

In Brown's paper, an editors' note mentioned a hybrid. I strongly recommend that ECHO rigorously evaluate it for invasibility and control before considering release *[Eds' Note: The developer asserts it is a non-GMO sterile hybrid cross]*. Also, either this species or a close relative (*P. setaceum*) is being promoted in Thailand and the Philippines (and probably other parts of Asia), though mostly as an ornamental—it is a spectacularly pretty addition to rock gardens. In some places it is promoted under the misnomer 'Purple Vetiver.'

### *Stylosanthes guianensis*: Common Stylo

*Stylosanthes guianensi*s appears to be highly invasive almost everywhere it has been introduced. PIER gives it high invasiveness and high risk ratings, and recommends rejecting it for importation. In Australia, common stylo is a weed of open woodlands, grasslands, floodplains, levee banks, roadsides, disturbed sites, waste areas and crops in tropical and sub-tropical regions. The plants are considered invasive and environmental weeds in Taiwan (Shan-Hua Wu *et al.* 2003), Pacific Islands (PIER), and Hawai'i (Chakraborty 2004). Some *Stylosanthes* species, in particular *S. guianensis*, have been deemed a conservation threat because they are too aggressive and easily invade areas outside pastures in Australia (Maass & Sawkins 2004). *Stylosanthes* can dominate pasture, causing long-term effects such as major rises in soil acidity, a decline in biodiversity and increased risk of soil erosion (Jones *et al.* 1997). Other detrimental effects include loss of soil surface stability, nutrient depletion and vegetation changes, including weed invasion (Maass & Sawkins 2004:59).

### *Arachis pintoi*: Pinto Peanut

Yay, finally! This species does not appear to be invasive in the least. PIER gives it a -1 rating, safe as safe can be. It has many benefits, as Brown mentions, but also provides a fast-growing groundcover that can protect soil against erosion caused by destructive raindrops. Promote this crop!

### *Leucaena leucocephala*

*Leucaena leucocephala* was a mainstay of the Green Revolution. The editor already correctly noted in Brown's article that *Leucaena leucocephala* can become a serious invasive pest in some countries. It can sometimes spread to become a troublesome weed, resulting in a monoculture (McNeely & Scherr, 2003:81).

PIER: Gives it a 'high risk' and a 'Reject' score. "forms extensive and dense thickets displacing the original vegetation and reducing species richness ... forms dense thickets, excluding all plants ... grown for fodder, but unless severely grazed or controlled, it spreads rampantly throughout adjacent areas ... in Hawai'i, naturalized and very common, sometimes forming the dominant element of the vegetation, in low elevation, dry, disturbed habitats ..."

CABI: "an aggressive colonizer of ruderal sites and secondary or disturbed vegetation ... declared a category 2 weed in South Africa ... listed as invasive species on Puerto Rico, one of the most problematic invasives on the island ... impacts include reduction in land area for activities such as farming when the species becomes weedy on abandoned cultivated land or pasture ... possible allelopathic effects ... outcompetes other vegetation, resulting in reduction of species diversity ... a potential habitat transformer ... degrading native forests in Hawai'i ... a number of examples of where monospecific thickets of *L. leucocephala* are degrading the indigenous flora ... in Ghana it is competing with rare endemic species ... introduced to Guam to reforest bombed areas, but now preventing the establishment of indigenous species ... preventing the regeneration of native forest vegetation in Mauritius ... while highly useful as a fodder plant, it is toxic to livestock if it is used in too great a quantity in the diet."

GISD: "listed as one of the '100 of the World's Worst Invasive Alien Species' ... can form dense monospecific thickets and is difficult to eradicate once established ... renders extensive areas unusable and inaccessible and threatens native plants ... not known to invade undisturbed closed forest habitats ... reported as a weed in >20 countries across all continents except Europe and Antarctica ... a weed of open, often coastal or riverine habitats, semi-natural, and other disturbed or ruderal sites and occasionally in agricultural land ... can form dense monospecific thickets which are reported to be replacing native forest in some areas and threatening endemic species of conservation concern in some areas ... can render extensive areas of disturbed ground unusable and inaccessible."

### *Gliricidia sepium*

Not listed as invasive by GISD. This species is extremely useful as a nurse plant for native seedlings in tropical forest restoration and is extensively used in agroforestry.

PIER: "Low invasion risk ... can grow into monospecific stands" [I've never seen it do that.]

CABI: "a moderate or potentially invasive species ... an adaptable, fast growing tree, with the ability to disperse seeds up to 40 m from the parent tree from exploding pods ... a colonizer of disturbed ground ... has become a weed in Jamaica ... regarded as a potential weed in Australia."

## Where do we go from here?

Though somewhat of a cliché, it's true that life is a series of trade-offs or compromises. Potentially invasive forage crops are no exception. In many situations, the benefits of introducing a potentially invasive species greatly outweigh the costs; perhaps many of Brown's readers live in such contexts. In places where rural agricultural development takes place, many (if not most) of these invasive species may be already established but underutilized. Promoting their use might control their spread into undesirable places. On the other hand, often native analogs can be found that offer similar benefits to potentially invasive species, yet the native plants have been overlooked, probably because of our almost universal bias towards exotic species when utility is the chief consideration.

When considering whether to introduce or reintroduce any organism (not just forage crops), several considerations should be taken into account. What is the organism's track record elsewhere—is it known to be invasive? If so, how risky is it and how is it managed (Hulme 2012)? NGOs with resources such as ECHO should be carrying out extensive weed assessment studies before promoting suspect crops. Many such risk assessment frameworks are available, such as in Driscoll *et al.* (2014:16625), and can be adapted to specific contexts.

National biosecurity has proven extremely successful and cost-effective in managing novel invasive species introductions in countries that take it seriously, such as New Zealand and Australia (Springborn *et al.* 2011), although since many invasive species have already colonized, it is perhaps a case of too little too late. In fact, stringent biosecurity can bring huge economic benefits (Simberloff *et al.* 2013:61; Keller *et al.* 2007). But many of us work in countries with inadequate or poorly implemented biosecurity frameworks, where regulations covering invasive species are not enforced on the ground, in the villages, and on the farms. In such cases, a culture of "every man doing what is right in his own sight" seems to reign. Some argue, "I will put the needs of the communities over the protection of the environment," but this is a patently misleading and self-defeating argument since such a dichotomy does not exist—what is bad for the environment will ultimately be bad for communities living in that environment.

Where an action has a suspected risk of causing harm to humans or the environment, and in the absence of a scientific consensus, the Precautionary Principle places the burden of proof (that an action or policy is not harmful) on those taking the action. Those (including us) who would undertake risky initiatives must bear the responsibility for ensuring that they will not cause harm.

> *"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."*

Wingspread Statement on the Precautionary Principle, Jan. 1998

Currently, the public bears the cost of environmental weeds that have escaped from pastures (Driscoll *et al.* 2014). The agribusiness industry continues to create new plants, promote and release them, with little thought of negative consequences and with no legal or financial culpability. Driscoll and Catford (2014) urge governments to include potential environmental damage when screening new pasture varieties, and to introduce a 'polluter pays' penalty system. Though it is a great idea, I don't see it happening anytime soon—there are powerful, international, vested interests in agribusiness.

Before we decide whether or not to promote or release a potentially invasive species, and after first doing a risk assessment, we development and extension workers might do well to ask ourselves one question: "Would I be willing to be legally responsible for the costs incurred by the people of this nation if this species turns out to be invasive?" Personally, I think agribusiness, NGOs, and development workers who take such risk upon themselves should be held legally responsible in the case of invasive outbreaks, and financially so for agribusiness.

Let's consider native and local alternatives that might offer similar benefits with reduced risk. The ECHO Asia Seed Bank is already trying to do this . For example, non-invasive vetiver grass (*Chrysopogon zizanioides*) has moderate potential as a fodder crop but carries none of the risks mentioned above. Several closely related species can be found in Africa, Thailand and elsewhere. Though fertile and potentially invasive outside of their original distribution, they are being used within their normal range effectively and safely in several initiatives (for example *C. nigricans* in Ghana and *C. nemoralis* in Thailand). Another example is the use of Indonesian albizia (*Paraserianthes falcataria*) within its natural distribution of Eastern Indonesia and Papua New Guinea. Officially the fastest-growing tree in the world, this species tends to become somewhat invasive when introduced to new areas (like the Philippines), but is an excellent alternative to *Leucaena leucocephala* in its natural range. Extension workers are perfectly positioned to work with local indigenous people to identify such native analogs of potentially harmful exotic invasives.

Finally, I would like to point out that even when a plant has become a significant environmental, social and/or economic burden, there is still hope. Eradication is often possible! Despite widespread belief to the contrary, eradication technologies have improved to the point where eradication attempts are feasible. Genovesi (2011) reviewed more than 1,000 attempted eradications, including of some long-standing invasions, finding that 86% of these had succeeded. The benefits of eradication can be enormous. Allan and colleagues (2010) found that eradication of invasive honeysuckle drastically reduced the risk of tick-borne Lyme Disease in the United States, stating "management of biological invasions may help ameliorate the burden of vector-borne diseases on human health." Eradication, where possible, can be far cheaper than long-term management of invasives. Early extirpation of introduced plants in New Zealand costs on average 40 times less than later attempts (Simberloff *et al.* 2013:61). Eradication, especially using ecological restoration techniques, can restore ecosystem services that have been lost to an invasion.

In conclusion, while we cannot and should not encourage bans on all invasive species, some certainly ought to be banned in the places where we work. At the very least, we should proceed with a full and informed perspective. I don't want to shame anyone, but I want to call for a measure of responsibility and wise consideration about how we use specific forage crops and other plant species that could be invasive. As community development workers, we must consider our responsibility as we think about introducing species that many cause potential long-term suffering. Let us not carry on blithely, recommending a suite of plants that offer some benefits, without at least strongly cautioning of their potential disastrous impacts. Otherwise we will jeopardize the very goal we strive for, that is included in Brown's title: livelihood improvement.

*[Author's Note: Though I primarily consult for LEAD Asia and its partners, I am happy to help others with any environmental and development issues, particularly in developing nations and in Asia. I can be contacted at anura@wbt.org.]*

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## Appendix

*[Note from the Eds.': Below is a follow-up warning and helpful information from the ECHO Seed Bank regarding plant introductions:]*

### The Nature of Plant Introduction: Some Important Cautions

ECHO supplies small seed packets for trial. It is important to understand that the plants must be treated at first as experimental before making recommendations to members of your community. Many, many development workers have introduced and promoted 'miracle technologies' and 'wonder plants' before giving them adequate trial and experimentation on-site. Not even studies in the same country can guarantee acceptance or success. Hasty introductions of new ideas or plants are likely to encounter serious problems. Farmers may have planted their fields with the new varieties or invested their savings in the new tool when the problems surface; perhaps a pest or disease strikes, or the equipment is faulty or unsuitable. In the end, farming families will suffer, and the development worker will understandably have a very difficult time promoting any further ideas or innovations. People may lose confidence or trust, with serious consequences for your work or ministry.

There are many advantages to conducting your own trials before disseminating seeds in the wider community. It is important to know whether the plant can grow in your area before farmers devote land and time to cultivating it. Through conducting trials you may find the best 'window' in your seasons for the optimal performance. You receive only a small packet of seeds from ECHO; if the plants produce well, you will have plenty of seeds to share. If the plants do not grow and produce seed, perhaps they are not suited to your region. Should the species be enthusiastically accepted, ECHO can refer you to commercial sources for some seeds if you need larger quantities or want to broaden the genetic base. If the plant holds great promise in your area, it is best to obtain more seeds from another source before the planting areas become too large. Genetic diversity not only offers potential for superior plants to be identified, but also affords protection in case of disease outbreak.

Beyond avoiding the risk of total planting failure, small trials allow you to evaluate the 'weed potential' of certain species in your area. Watch the planting carefully the first few seasons to make sure it is not likely to become a problem plant. Unfortunately, one definition of a weed, "plants which thrive under stressed conditions, often with high seed production," fits some of the plants in ECHO's seedbank. We are very aware of this risk and have in fact eliminated certain species from our seedbank when the danger of introducing a weed seemed too great. However, hardy plants which can establish themselves may be a great blessing in many situations; for example, it is difficult to imagine a tree which could become a pest in certain areas of Africa or Haiti with severe fuelwood shortages. Sending out only small trial packets of seed is another safeguard against introducing a weed, as too-aggressive plants may be identified and controlled easily in a small area. Finally, remember that the plants in ECHO's seedbank are commonly accepted food plants somewhere in the world, even if very localized. In this, too, there is a measure of safety as we can all learn and benefit from the years of plant selection by people in other parts of the world.

In all cases, we look upon those who request seed as collaborators with us in field trials. This does not mean that you must do elaborate experimentation, but we do expect you to take time to write to us after the food has been harvested, letting us know your general impressions on its suitability to the region and the culture. A seed trial report form (in English, French, or Spanish) is sent along with your seeds. We enter your results in our database and use this information to make more refined recommendations to others and to share with interested scientists. These reports are very important to us, to be aware of germination or weediness problems, as well as to learn of successful introductions and acceptance of the plant in the community. We are always glad to receive the seed trial reports, but we also have special interest in longer-term results of plant introductions and the effects of ECHO's work. If you receive seed from ECHO and the plants are adopted in the fields and gardens in your area, please let us know.

# Book Review: Shifting Cultivation and Environmental Change:

## Indigenous People, Agriculture and Forest Conservation

*Review by Douglas M. Fraiser*

Edited by Malcolm F. Cairns. © 2015. Published by Routledge. 1058 pages (paperback). Available in electronic, paperback, and hardback formats from Amazon, Apple, Barnes & Noble, eBooks.com, Google eBooks, Kobo, and Waterston's. (Click distributor's name for link.)

Shifting cultivation (also known as "swidden farming" and "slash-and-burn") is an ancient practice that continues to play a major role in the livelihood of marginalized communities, and to take center stage in discussions of economic development and environmental impact. This first book in Routledge's three-volume series on shifting cultivation should be useful to swidden communities, to those working with them in their efforts to achieve a prosperous and sustainable future, and to policy-makers who desire to make well-informed decisions.

The book brings out several important themes. One is the tremendous difference between the two forms of shifting cultivation. Traditional rotational systems, oriented toward subsistence, are environmentally sustainable; pioneering systems, oriented toward cash income, typically are not. Shifting Cultivation also documents the role of forests in preventing soil erosion, flooding, and climate degradation, and brings out the compatibility of traditional rotational systems with conservation efforts.

The book has four parts. Part 1 takes us through the history of shifting cultivation and its current trends, helping us develop a balanced understanding of the practice's place in mankind's quest for survival.

Part 2 brings out the environmental benefits of traditional rotational systems. Chapters on the relationship between shifting cultivation and climate bring out that swidden fallows help prevent the flooding that threatens many urban areas, and explore mechanisms that reward farmers for maintaining the forests that are an integral part of rotational swidden systems. The section's final chapters demonstrate swidden farming's contribution to biodiversity.

Part 3, focusing on the economic aspects of swidden systems, brings out often-overlooked relationships between shifting cultivation and cash economies, and shows that efforts to replace swidden farming with "modern" methods frequently lead to environmental damage and expose farmers to greater economic risk.


Part 4 rounds out the volume with some additional observations. The final chapter, by Terry Rambo, is an insightful reflection on several decades' interaction with swidden communities. He brings out the crucial difference between rotational and pioneering systems, the tremendous influence of external forces on local situations, and the surprising reappearance of shifting cultivation in areas where it had been abandoned. He concludes with a cautious prediction that shifting cultivation will likely continue to be used by resource-poor farmers where there are no viable alternatives.

This volume should be of value to anyone concerned with swidden farming, with the people who practice it, and with the natural resources that it influences. Shifting Cultivation is worth a long and slow read.

# Book Review:
# Where There is No Animal Doctor

*Review by Craig Soderberg*

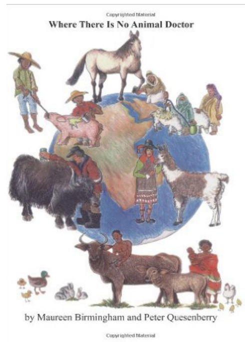
*[Editor's Note: Reprinted with permission from Appropriate Technology and Craig Soderberg. Thai and Burmese versions of the book are available at the ECHO Asia office.]*

Where There is No Animal Doctor, by Maureen Birmingham and Peter Quesenberry. Published by Christian Veterinary Mission. ISBN 9781886532113.

Many rural people around the world raise livestock in areas where there is no veterinarian. But livestock is a very important part of their life. So prevention, control, and treatment of disease for their animals is very important. The authors of this book hope that the users of this book will be able to realize which disease conditions they can handle on their own, and when to call for help from more experienced animal health workers.

The book contains the following chapters: 1. health and disease, 2. restraint and handling, aging and weight, 3. clinical examination and diagnosis, 4. principles of treatment, 5. first aid, 6. infectious diseases: prevention and control, 7. nutrition, 8. parasites found on the skin, 9. parasites inside the body, 10. reproduction, 11. digestive system, 12. respiratory system, 13. muscular system, 14, skin systems (including horns and hooves), 15. skeletal system, 16. urinary systems, 17. nervous system, 18. the circulatory, blood and lymphatic systems, 19. endocrine system, 20. organs of special sense, 21. miscellaneous disorders, 22. public health diseases, 23. laboratory procedures, 24. poultry health, 25. nutrition appendix, 26. insecticide use for control of external parasites, 27. internal parasite appendix, 28. using medicine safely and effectively, 29. common medicines and their doses. The book ends with a section for vocabulary, a general index, about the authors, and references.

The book was written in order to help animal help agents (AHAs) in these areas: good hygiene and sanitation; proper shelter and environment; adequate quantities of good drinking water; proper nutrition; proper selection of breeding animals; prevention, control and treatment of diseases; well-kept records with breeding dates; good daily observation; management and decision-making; a means of marketing livestock and livestock products.




Each chapter has easy-to-read explanations, easy-to-understand black and white illustrations, and good summaries.

The book is organized in the same order that the AHA should approach a sick animal. First he should know the basics about the disease (e.g. chronic/acute, infectious/non-infectious, contagious/non-contagious). Second, he should know the basics about the body systems. Third, he should properly restrain the animal. Fourth, he should take a history and examine the animal and the environment. Fifth, he should determine whether the animal is sick. Sixth, he should identify the system(s) of the body affected. Seventh, he should identify the disease affecting that system. Eighth, he should treat, control, and prevent the disease.

This book is for anyone interested in improving the health of livestock, regardless of whether they own the livestock themselves.

# EAN 24 Correction

Please note that in the article "Tricho-Composting in Bangladesh" in ECHO Asia Note 24 a correction needs to be made. On page 12, in the section "From Where is the Trichoderma Obtained?" it says: "Soil samples from the root zones are diluted in distilled water up to 106 times." However this should be "Soil samples from the root zones are diluted in distilled water $10^6$ times (ten to the power of six or 1,000,000 times)." Apologies for any confusion.

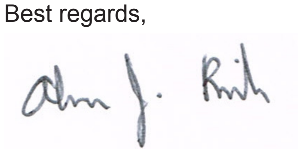
# Call for Articles, Insights

We are delighted that you receive and read our ECHO Asia Notes. We hope that the information contained here within is useful to you and most importantly, useful to those whom you serve. I wanted to highlight a few things that you may find add value to your free membership to ECHOcommunity.org and can help you be more effective.

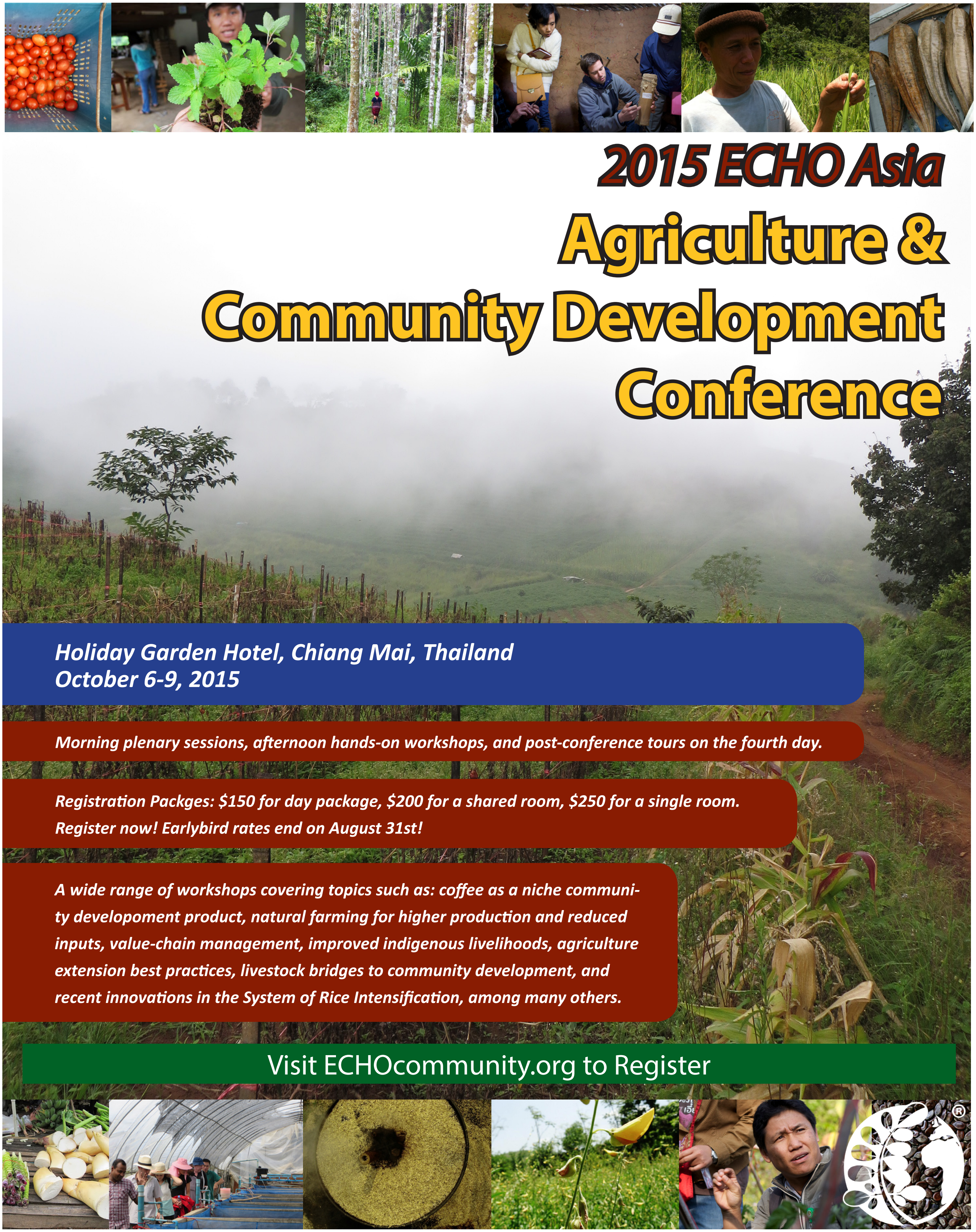
- Please do remember that a "Development Worker" membership entitles you to 10 free trial packets of seed per year, so be sure to take advantage of this! If you would like more seed packets or larger quantities of some seeds (especially green manure/cover crops), we do have additional seeds for sale, and our seed bank catalog is available online.
- Please also know that besides being written in English, our ECHO Asia Notes are translated and available for freed download in Thai, Khmer, Burmese, Mandarin, Bahasa Indonesia, and Vietnamese languages.
- Additionally, we have a special place in the Asia section of ECHOcommunity for additional technical resources, free book downloads, and presentations from past ECHO Asia events and workshops.
- If you have never joined us for an event, please consider doing so- our Biennial Conference is happening this October and will be an excellent place to learn together, network, share ideas, and gain practical skills in agricultural and community development.

In addition to using our information, we strongly encourage you to provide feedback to us in order to better know how to serve you and help us to refine our resources and delivery. In the future, we hope to have an automated feedback system, seed evaluation system, and better monitoring and evaluation so that we can better equip workers. We encourage you to share success stories, lessons learned, insights, Facebook posts, etc. with us to keep us abreast about what you are trying and what is working in your context. Additionally, if you have any ideas or would like to write an article for an upcoming ECHO Asia Note, we invite you to do so! Thank you for reading, and please do stay in touch!

Best regards,



Abram J. Bicksler, Ph.D.
Director, ECHO Asia Impact Center


2015 ECHO Asia
Agriculture &
Community Development
Conference
Holiday Garden Hotel, Chiang Mai, Thailand
October 6-9, 2015
Morning plenary sessions, afternoon hands-on workshops, and post-conference tours on the fourth day.
Registration Packges: $150 for day package, $200 for a shared room, $250 for a single room.
Register now! Earlybird rates end on August 31st!
A wide range of workshops covering topics such as: coffee as a niche community developoment product, natural farming for higher production and reduced inputs, value-chain management, improved indigenous livelihoods, agriculture extension best practices, livestock bridges to community development, and recent innovations in the System of Rice Intensification, among many others.
Visit ECHOcommunity.org to Register

# 2015 ECHO Asia
# Agriculture & Community Development Conference

## Speakers List

To provide an idea of some of the speakers and topics that will be featured in the morning plenary sessions, here are the morning plenary speakers that will share with conference participants:

- Samuel Gurel, CEO of Torch Coffee, will discuss coffee as a development tool and niche agriculture product in a talk entitled "The WHY Behind Coffee Development."
- Keith Mikkelson, the Executive Director and co-founder of Aloha House and Natural Farm, as well as the author of "Sustainable Agriculture in the Tropics," will be giving a talk entitled "Natural Farming: A Key to Higher Production with Reduced Inputs."
- Tom Love, Agriculture Advisor at USAID, will be giving a talk about the nature of value and how it is created, entitled "The Mystery of Value."
- Siem Sun, manager of the Improved Indigenous Livelihoods program for International Cooperation Cambodia, will be discussing livelihoods improvement through development and giving a talk entitled "Community Solutions to the Changing Context of Livelihoods in Northeastern Cambodia of Indigenous Minorities."
- Dr. Paul McNamara from the University of Illinois and Director of the Modernizing Extension and Advisory Services (MEAS) will share about lessons learned from agriculture extension best practices.
- Dr. Peter Quesenberry from Christian Veterinary Mission and the Mekong Minority Foundation, as well as author of the book "Where there is No Animal Doctor," will discuss livestock and community development and give a talk entitled "Livestock Bridges to Community Development and Livestock Emergency Guidelines and Standards."
- Mother and daughter team, Wanpen Channarod and Phicharinee Suksree, innovative farmers from Nakhon Sawan, Thailand, will share about recent innovations in the System of Rice Intensification (SRI) and lessons learned.
- Dr. Sabine Scheucher is a botanist and horticultural therapist from Austria who has worked in Nepal, Tibet, and North-India. She will be sharing her research on culinary herbs, specialty greens, and high value fruits as an alternative for small-scale farming in the tropics and sub-tropics.
- Dr. Bhuwon Sthapit, senior Scientist and Regional Project Coordinator for Bioversity Nepal will speak on community seed banking.

To learn more about the upcoming ECHO Asia Agriculture and Community Development Conference and to register for the event, please visit ECHOcommunity.org.

## Post-Conference Tours

Following three days of plenary sessions and workshops, the ECHO Asia Agriculture & Community Development Conference will culminate in a fourth day of field trips and site visits to local community development projects, farms, and businesses. The tour is included in the cost of registration. To give you an idea of what's in store, here is a list of current post-conference tours that conference participants can select from:

- Natural building methods at Mae Mut Garden farm and small farm resource center.
- Tropical forest restoration and stewardship with the Chiang Mai University Forest Restoration Research Unit (FORRU).
- Community-appropriate biochar research and application at the Warm Heart Small Farm Resource Center.
- Integrated Pest Management and Biological Pest Control at the Chiang Mai Pest Management Center.
- System of Rice Intensification with a visit to a Northern Thai farmer's field in the Chiang Rai area. Fa Mui has grown organic brown rice and produced GABBA using SRI for over four years (overnight; additional fees apply).
- Vermiculture and mushroom farming at Mae Jo University
- Coffee farming, processing, and cupping.
- Dairy farming and farmer cooperatives with a local Thai dairy cooperative.

***Register now! Early bird rates expire on August 31st!***

## Poster Session

In addition to the plenary and workshop sessions this year, we also would like to invite delegates to participate in a poster session as a means to share and exchange other information. This might be a particularly suitable venue for any research or information which academics, graduate students, or practitioners have conducted or created regarding experimentation, crop evaluations, or to showcase an agricultural development project. Presenters are asked to submit a brief title and synopsis (2-3 sentences) ahead of time, and e-mail those to echoasia@echonet.org.

Please visit ECHOcommunity.org for full details on the poster session.