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Soil Amendments for Healthier Soils

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Editors' Note: Dr. Tom Thompson currently serves as Associate Dean and Director of Global Program's in Virginia Tech's College of Agriculture and Life Sciences. He brings to the table an extensive background in teaching and research in the fields of Agronomy and Soil Science and willingly serves ECHO and its network as a consultant, partner, and friend.

Introduction

Soil chemical, physical, and biological properties range from those highly favorable to plant growth to those highly unfavorable to plant growth. It is rare—especially in the tropics—to find a soil in its natural state in which all properties are highly favorable to plant growth. Nevertheless, as long as there is sufficient soil depth to provide an adequately deep and well-drained root zone, proper amendment and management of soil properties can result in almost any soil becoming suitable for plant growth. Even naturally infertile soils and soils with very low water-holding capacity can produce extraordinarily high crop yields with proper management and inputs.

Soil properties that negatively affect plant growth must be addressed by adding amendments, physical manipulation (tillage), changing soil management practices, or combinations of these three actions. For example, soil compaction can only be corrected by tilling the soil to break up compacted zones. However, addition of soil amendments (especially organic materials) and altering soil management practices may help to prevent formation of compacted zones. Unfavorable soil chemical properties require soil amendments, but proper soil management can slow down the recurrence of such problems. A biological problem, such as an infestation of soil-borne fungi or of parasitic nematodes, can be addressed quickly through chemical means, or more slowly and sustainably by changing crop and soil management practices.

The objectives of this document are to 1) define soil amendments, 2) discuss common soil problems that can be treated by adding amendments, and 3) describe common types of soil amendments.

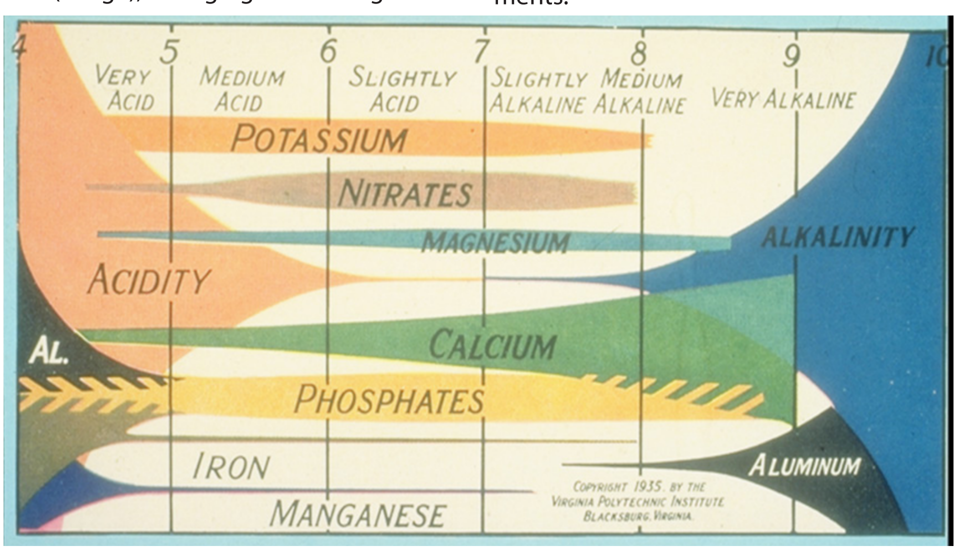

Figure 1: *Generalized effects of soil pH on availability of nutrients and other elements. From Virginia Agricultural Experiment Station Bulletin No. 136, 1935.*

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Soil amendments defined

Soil amendments are not the same as chemical fertilizers. Fertilizers are added to soils specifically to add plant-available nutrients. Soil amendments, on the other hand, are used primarily to correct adverse chemical, physical or biological soil properties other than low nutrient availability. The distinction between amendments and fertilizers is not always clear-cut. For example, organic matter can serve as both fertilizer and soil amendment. In this paper, we will limit our discussion to amendments.

Common soil problems treated with amendments

A number of common soil problems can be treated by adding soil amendments. Some of these problems are described below.

Soil acidity and alkalinity

Soil pH is one of the most important and fundamental of soil properties. Soil pH controls the bioavailability of many essential nutrients (Figure 1, Page 1), determines the relative toxicity of various metals in soils, and strongly affects biological activity in soils. The pH is a measure of soil acidity and alkalinity. The pH scale ranges from 0 to 14; with a pH of 7 being "neutral", while values below 7 are acidic, and values above 7 are alkaline. For most plants, a pH of about 6 is ideal, although some acid-loving plants will thrive in soils with a pH as low as 4 and alkaline-tolerant plants can survive in soils with a pH up to 10. Even within a plant's "tolerable" pH range, plant health and yield can suffer at the outer limits of the range. Many plants grown in the humid tropics and sub-tropics are adapted to moderately acid soil pH values (Table 1), including rice, coffee, pineapple, and passion fruit. This is fortunate, because most tropical soils tend to be naturally acidic!

Table 1: *Optimum soil pH ranges for selected crops. From Plant Nutrient Management in Hawaii's Soils, Approaches for Tropical and Subtropical Agriculture. R. Uchida and N.V. Hue, CTAHR, University of Hawaii at Manoa, 2000.*

Crop	pH	Crop	pH
Maize	5.5-6.7	Passion fruit	5.0-6.0
Rice	5.0-6.5	Pineapple	4.7-5.5
Sorghum	5.5-7.0	Guava	5.5-6.8
Coffee	5.0-6.0	Most vegetables	6.0-6.8
Avocado	6.2-6.5	Kikuyu grass	5.5-6.5
Banana	5.5-6.5	Sugarcane	5.0-6.5
Citrus	6.0-6.8	Taro	5.5-6.5

Soil acidity is a natural consequence of soil exposed to humid climates for long periods (e.g. centuries to thousands of years). Such conditions will result in losses of non-acidic soil elements such as calcium and magnesium. At the same time, acidic elements such as aluminum and iron persist in soils, become progressively more soluble, and react to produce acid. In cases where soils are acidic, it is important to consider crop acid tolerance before applying amendments to raise soil pH.

In highly acid soils (pH<5), bioavailability of N, P, and K is often low. At the same time, aluminum, iron, and other metals may become so soluble that they are toxic to plants. In fact, aluminum and manganese toxicity are very serious problems for plants growing in highly acid soils; plants that can withstand low soil pH are able to tolerate high concentrations of available aluminum and manganese in soil (Yost 2000). Soil acidity also adversely affects microbial activity, with bacteria becoming less active and fungi more active in highly acid soils. Growth of beneficial nitrogen-fixing bacteria is usually inhibited in highly acid soils.

Figure 2: *Sodic soil in Arizona, USA. Note the complete absence of vegetation in the foreground. Photo by T.L. Thompson.*

Alkaline soils have a pH higher than 7. These soils are most common in semi-arid and arid regions, and where soils are salty because of salts in irrigation water and/or poor drainage. Alkaline soils can also occur in sub-humid regions where soils have formed on alkaline parent materials such as limestone. Soil pH values up to 8 rarely cause problems for plants (acid-loving plants are an exception). However, pH above 8 will often result in severe deficiencies of micronutrients such as iron, zinc, and manganese.

Soil alkalinity most often is a result of one of two conditions. The first and most common is the occurrence of calcium carbonate (lime) in soils. Many dry-region soils have natural accumulations of lime, because this moderately-soluble mineral persists in soils. Wherever soils contain natural lime (calcareous soils), soil pH will stay above pH 7.0 and may be as high as 8.3. Soil alkalinity can also be caused by the presence of high amounts of sodium along with associated carbonates. Such cases usually results when sodium is added to soil (e.g. in irrigation water) accompanied by poor soil drainage, which prevents sodium from leaching below the root zone. Soils with high sodium content are referred to as sodic soils, and is a very serious soil condition that is difficult to correct (Figure 2).

Soil salinity and sodicity

Saline soils have accumulations of soluble salts in concentrations that can be harmful to plants. Just as with pH, soils have varying degrees of salinity, and plants have varying tolerance to soil salinity. Soil salinity is usually expressed

Table 2: *Salinity tolerance of selected crops. From FAO 29, Water Quality for Agriculture, UN-FAO, 1994.*

Tolerance	Crop	Tolerance	Crop	Tolerance	Crop
High Soil EC<6	Barley	Moderate Soil EC<3	Cowpea	Low Soil EC<1	Groundnut
	Cotton		Wheat		Maize
	Bermudagrass		Beet		Rice
	Asparagus		Squash		Cole crops
	Date palm		Fig		Potato
	Wheatgrass		Olive		Tomato
			Pineapple		Most fruits

as electrical conductivity (EC) or as TDS (total dissolved solids). A TDS value of 640 ppm approximately corresponds to an EC of 1 dS/m. Salinity adversely affects plants by reducing the availability of soil water to plants, since the salts pull water away from plants through osmosis. Most plants that are well adapted to the humid and sub-humid tropics cannot tolerate soil salinity and may be harmed by even modest amounts of soil salinity. On the other hand, there are plant species that can tolerate high amounts of soil salinity, though few of these tend to be crop species (Table 2). The salinity tolerance ranking shown in Table 2 is a general guide only, as plant tolerance to salinity also depends on growing conditions and other stressors. The negative effects of salinity can be mitigated—though not eliminated—through proper management of soil moisture, by keeping the root zone moist (not wet) at all times. A moist root zone will dilute salt concentrations. Overly wet root zones, however, are detrimental for plants. Drip irrigation is an especially good tool for managing salinity, because it is the best method for managing root zone soil moisture.

Salinity and sodicity often occur together, but sodicity is usually the more serious problem of the two because it is more difficult to correct. Sodicity is the accumulation of high amounts of sodium on soil clays, especially in the absence of adequate amounts of calcium. Sodicity does not harm plants directly, but causes soil structure to disintegrate and can make soils impermeable to water.

Soil amendments

Lime

Amendments that neutralize soil acidity are bases, chemically speaking. "Lime" is a general term that encompasses several materials derived from naturally occurring limestone. Agricultural lime is the pulverized form of limestone ($CaCO_3$) most commonly used as a liming material. Agricultural lime varies in its effectiveness depending on chemical purity and particle size (smaller particles are most effective). Hydrated lime ($Ca(OH)_2$) and quicklime (CaO) are formed when agricultural lime is heated; they are usually more expensive than agricultural lime, and therefore less commonly used. Quicklime must be used with caution, as it can be caustic to humans and plants. Dolomitic lime ($CaMg(CO_3)_2$) is a naturally-occurring mixture of calcium and magnesium carbonates that can be used in place of agricultural lime. Marl is a soil material that contains high concentrations of calcium carbonate, but its use is not recommended unless no other liming materials are available, because of its low purity.

Although liming materials are applied to soils primarily to neutralize acidity, they also add calcium (and magnesium, in the case of dolomitic lime), which is essential for plants and often deficient in acid soils. The relative effectiveness of liming materials is expressed as the calcium carbonate equivalent (CCE); pure calcium carbonate has a CCE of 100 (Table 3). The CCE depends on the chemical composition but also on the particle size. Large lime particles will react more slowly in soils than fine particles, and hence will take longer to have the same acid-neutralizing effect. In addition to neutralizing acidity, lime application to tropical soils may improve soil aggregation, porosity, and bulk density. Acid soils should normally be limed to pH 6.0 – 6.5. The correct amount of lime to add to an acidic soil depends on two factors—the pH of the soil and the soil buffering capacity, also known as "reserve acidity." Soils with high clay content and high cation exchange capacity (CEC) tend to have high buffering capacity. The only way to accurately determine a specific soil's lime requirement is to have the soil tested by a reputable soil testing laboratory. The laboratory will measure pH and buffering capacity and recommend a lime rate, usually in tons/ha; the rate will assume that the liming material has a CCE of 100%. If it is impossible to send a soil sample to a laboratory, lime requirement can be estimated by incubating samples of moist soil with differing amounts/rates of lime. After five days, the pH is measured (Sonon and Kissel 2015), and soil should be limed using the rate which resulted in a pH closest to 6.0 – 6.5. However, this incubation method should only be used if laboratory soil analysis is impossible, because the accuracy of the method has not been thoroughly evaluated.

Table 3: *Calcium Carbonate Equivalent of Certain Liming Materials. From M. Alley. Agronomy Handbook, Virginia Cooperative Extension, 2000.*

Liming Material	Calcium Carbonate Equivalent
Agricultural lime-calcium carbonate	100
Dolomitic lime	108
Quick lime	150-175
Hydrated lime	110-135
Marl-calcium carbonate	70-90

Gypsum

There are no amendments to counteract soluble salts in soils or lessen their effects on plant growth. The only cure for soil salinity is adequate leaching of salts below the root zone with high-quality irrigation water. If this is impossible, maintain optimum soil moisture to minimize salt stress, use irrigation methods that minimize salt in the root zone (e.g. drip irrigation), and/or grow salt-tolerant crops. Applications of gypsum ($CaSO_4.2H_2O$) can help rid soils of sodium, but not soluble salts, so long as drainage is adequate. The amount of gypsum to add increases with amount of sodium and soil cation exchange capacity.

Acids to neutralize alkalinity

Amendments that neutralize soil alkalinity are acids, chemically speaking. Such amendments are used much less frequently than alkaline liming materials. There are several reasons for this. First, sodic soils are often alkaline, but applying gypsum and leaching sodium from soils will usually lower pH to desirable levels. Second, many alkaline soils are calcareous. The pH of calcareous soils cannot be brought below 7.0 unless all calcium carbonate is neutralized, which will usually require prohibitive amounts of acid amendments. For these reasons, neutralizing alkaline soils is usually impractical for annual crops. However, neutralizing the root zone of tree crops is possible by adding acid-forming amendments such as sulfur, thiosulfate, and ferrous sulfate. The appropriate application rate of acid-forming amendments will depend on soil pH and buffering capacity, and should be determined through soil testing. Some useful related information is provided by Mickelbart and Stanton (2012).

Organic amendments

Organic amendments for soils are those of biological origin. There are a tremendous variety of organic amendments, including crop residues, manures, food or other wastes, organic fertilizers, biochar, compost, and others. The variety of organic amendments is almost endless; some common organics are shown in Table 4. In general, organic materials are not added to soils to control pH, but they can affect pH and plant response to pH. Organic amendments are normally added to soils to increase soil organic matter and/or to provide plant-available nutrients. Though a full discussion of organic amendments is outside the scope of this paper, I will make a few key points about organics.

One important property of organics is the carbon to nitrogen ratio (C:N). The carbon percentage of organics is fairly constant at 50-60% by weight. On the other hand, nitrogen percentage varies from well below 1% to more than 6%. Therefore, the C:N ratio of organics can be as low as 8 to as high as 200. In general, organic materials that are easily decomposed in soils have low C:N (i.e., they contain a high proportion of nitrogen) and are valuable as fertilizers. Manures, green crop residues, and food wastes are examples of such materials. When these materials are added to soils and microbial decomposition begins, they serve as nutrient sources for plant use. When these organic amendments decompose, the nutrients they provide are no more available or beneficial to plants than those from chemical fertilizers. However, the addition of organics to soils also includes the benefit of adding organic matter. The rate of organic matter decomposition is highly variable and depends on the chemical composition of organic material, C:N ratio, soil moisture, pH and temperature, and microbial populations. In general, microbial decomposition of organic materials is most rapid in moist, warm, and slightly acid soils.

Organic materials resistant to microbial decomposition and with high C:N ratios can serve as soil amendments but do not make good fertilizers. Brown crop residues and woody materials are examples. When they are added to soils and start to decompose, they may actually "consume" available nutrients for several weeks or months. These materials with a high C:N ratio resist decomposition, so they will persist in soils for a long time. They become an important part of humus, which contains stored carbon and which helps give soil its structure. Forming humus also encourages storage or "sequestration" of carbon in soils.

Table 4: *Common organic materials that can be applied to soils. From G. Evanylo. Urban Nutrient Management Handbook, Virginia Cooperative Extension, 2011.*

Agricultural	Municipal	Industrial
Manures	Wastewater	Paper mill sludge
Crop residues	Sludge (Biosolids)	Food processing waste
Vermicompost	Landscape wastes	Sawdust, wood chips
Compost*	Food waste	
	Paper waste	

** Compost can be made from virtually any organic material, including those listed in the table and other organics such as animal carcasses.*

Compost

In general, adding organic materials to soils will yield positive results. However, the exact results and the length of time to achieve them will depend on the nature of the organic inputs. Compost is an organic soil amendment made by piling and decomposing organic materials, resulting in a stable end product that will decompose slowly in soils (Evanylo 2011). Finished compost has a low C:N ratio but decomposes slowly in soils because it is chemically complex. Compost is normally not rich in nutrients and hence does not increase plant available nutrients in the short term. However, compost is a superb soil amendment. Compost can be made from virtually any organic material, as explained in a recent ECHO West Africa note (Gouba 2017). Long-term application of properly prepared compost to soil can improve its water-holding capacity, aggregation, fertility, and can encourage growth of beneficial microbes.

Biochar

Biochar has received much recent attention as a soil amendment. Biochar adds carbon to soil, can improve soil chemical and physical properties, and application of biochar can increase crop yield (Major, 2010). A recent ECHO Asia Note contained an extensive discussion of biochar (Shafer, 2018), and the reader is encouraged to consult this document for more details. Biochar can be a valuable soil amendment, but it is not a "magic potion" to solve all soil ills.

Microbes

Microbes are not usually considered soil amendments, although they may be added to soils to change specific soil biological properties. For example, Rhizobium bacteria are helpful inoculants for leguminous crops, fixing nitrogen that can nourish the plants. Likewise, mycorrhizael fungi can be added to support crops growing on degraded soils, for crops which can grow symbiotically with these fungi. Trichoderma fungi have also been added to soils as beneficial microbes to combat pathogenic organisms and for plant growth enhancement (Shelton 2018). Additions of microbes to soil is most beneficial to address specific situations, such as when planting a legume crop in a field for the first time, or adding mycorrhizael fungi to soils degraded by erosion or nutrient depletion.

Soil "stimulants"

A final group of soil additives are referred to as "stimulants", a term that is very broad and ill-defined. Manufacturers of such additives may make numerous claims, such as improving soil fertility, unlocking soil nutrients, improving plant tolerance to stress, to be soil probiotics, reduce or eliminate the need for fertilizers, and more. The large variety of such additives makes it impossible to provide specific recommendations. Some soil additives are legitimate products, with scientifically known and demonstrable modes of action, and with documented success. However, many so-called soil additives do not fit this description, so a few words of caution are in order. The well-known phrase, "If it sounds too good to be true, it probably is," applies very well to soil additives. Soils are not magical realms; a product claim that sounds magical is probably not legitimate. For example, soil microbial communities are very complex—additives that are purported to create sweeping changes in soil microbial communities are not likely to live up to their promises, unless the soil is highly degraded.

My best advice is to investigate the claims made about a soil additive. First, do the promised benefits seem reasonable, or do they sound magical? Second, can the promised benefits be explained scientifically? Third, have the benefits been verified through research by a neutral third party? Finally, is the vendor willing to answer questions and provide supporting information? If the answers to these questions are "no," then "Let the buyer beware"!

Summary

Soil amendments are added to soils to correct adverse chemical, physical or biological soil properties other than low nutrient availability. A thorough understanding of soil chemical properties through soil sampling and analysis is necessary to determine the type and rate of soil amendment that is necessary in a specific situation. Common types of soil amendments include inorganic amendments such as liming materials and gypsum, and organic materials such as crop and animal wastes, composts, and biochar. Additions of organic materials will usually improve soil properties and should be encouraged. When evaluating soil additives, consider whether or not they act in soils according to known modes of action that can be explained scientifically.

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The Value of a Seed: Growing a Network of Community Level Seed Banks in Asia

by Patrick Trail
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Editor's note: The year 2018 has brought many changes to ECHO Asia, including the acquirement and development of a new Small Farm Resource Center and Seed Bank on the outskirts of Chiang Mai, as well as the growth of an emerging network of Community Level Seed Banks. This article seeks to summarize the recent growth in these two areas, and to illustrate how the two will work in tandem to move forward the work of ECHO Asia and its network.

Figure 1: *The current ECHO Asia Seed Bank is located in Mae Ai, approximately 4 hours north of Chiang Mai, where ECHO Asia's main office is located.*

Introduction

As an organization that seeks to equip people with agricultural resources and skills, we often find ourselves coming back to the seed. Again and again we witness the value saving open-pollinated seeds, shedding light on locally adapted and underutilized plants of merit, and researching innovative low-cost seed storage technologies. These activities form the foundation of ECHO's ability to empower others in their endeavors to improve food and agricultural systems around the world.

Building on a longstanding history of seed bank operations, first in Florida, and now Asia and Africa, ECHO continues to expand its capacity for placing seeds into the hands of those in need. In 2009, with the establishment of Asia's Regional Impact Center and Seed Bank, the first step was taken in an ongoing process to house seeds of regional merit and local importance on location. To date, ECHO's first regional seedbank strives to meet a growing demand for locally-adapted, open-pollinated seed from within our network, and its success attests to the wisdom of its establishment. Distributing over 4,600 trial seed packets in 2017, from a selection of 175 different varieties, the Asia Seed Bank serviced network partners in 29 countries, with seeds grown and produced right here in SE Asia!

In light of these achievements however, demand for more seeds has stretched our capacity to fulfill the needs of a massive Asian audience, thus requiring our own explorations for further growth. This, combined with a growing challenge of moving seeds across borders, tightening seeds laws, and continued debates over ownership of genetic materials, has forced us into thinking very intentionally to the future of our seed banking activities. These questions have pushed us to consider how we might continue to serve our network in this critical realm.

ECHO's Response

A two-pronged approach to the aforementioned challenges forms the basis of ECHO's response and includes the (1) expansion of our regional seed bank, and (2) the formation of a regional network of community level seed banks (CLSB's).

This approach has recently been set in motion, and expansion of a new seed bank is now underway. The recent procurement of new land on the outskirts of Chiang Mai (just 25 minutes from the main office) has allowed for the expansion from our existing seed bank operation in Mae Ai (located 4 hours from the main office), and the establishment of a Small Farm Resource Center (SFRC) to be used for training and research purposes. This new and ongoing endeavor allows for significant growth of seed production and the overall capacity of our regional seed bank to service the needs of our network. In addition to housing an expanded seed bank, this site will significantly bolster our capacity for additional agricultural demonstration, innovation, and verification of the practices we seek to share.

With the construction of a larger cold-storage room for seeds, increased acreage for seed production plots, and closer proximity to the city, this site will serve as a crucial piece serving our regional network with a diverse variety of locally-adapted seeds.

While this increased seed bank capacity will undoubtedly multiply the seeds we can grow and disseminate, we recognize

Figure 2: *A local maize variety being grown out at the ECHO Asia Seed Bank.*

Figure 3: *The new ECHO Asia Small Farm Resource Center & Seed Bank site, located just 25 minutes outside of Chiang Mai, Thailand. Increased raised bed production of seeds is underway.*

the on-going challenges of the movement of seeds regionally, and the need for additional local in-country alternatives. Therefore, serving as a regional hub, this new Asia seed bank will support an emerging network of community level seed banks (CLSB's), located within countries of SE Asia and beyond. Thanks to the generous support of the Presbyterian Hunger Program, the Agroecology Learning Alliance of SE Asia (ALiSEA), the Stewardship Foundation, and generous individual givers, this network is beginning to grow and expand, one seedbank at a time.

ECHO Asia, serving in a directed training and capacity building role, and leveraging the efforts of partnering seed bank staff, will work to empower each CLSB to be adequately equipped to independently produce, store, and distribute seeds of local significance. Doing so successfully will result in (1) locally available seeds should access to our seeds become obstructed, (2) greater sharing of seeds of merit among the network, (3) safeguarding of varieties should disaster strike one seed bank or region, and (4) the slowing of crop biodiversity loss locally and regionally.

A Network Grows Out of Myanmar

On a spectrum of developed and sophisticated, on down to simple and appropriate, a seed bank can look very differently depending on the context and its desired function. On ECHO's Global Farm, we operate a seedbank equipped with an impressive walk-in cold-storage unit capable of precisely controlling temperature and humidity, suited for storing seeds for several years at a time. At our regional seed bank located in Thailand, we operate a less sophisticated seed storage room using a split unit air conditioning system, a 'cool-bot' sensor, and a spray-foam insulated room, designed to be more replicable and affordable for those within our network of partner organizations. Further still, for those on a lower budget and lacking access to the necessary technologies, and reliable electricity, we have had to explore, test, and experiment with other appropriate seed bank options for local communities within the region. These include earthbag building techniques and buried clay cisterns for temperature stabilization, bicycle vacuum sealing technologies, and locally available desiccant materials for drying down seeds.

To date, it has been a combination of the two latter options on the spectrum that have found their way to form a set of functioning seed banks on the ground. Working in Myanmar, in the Irrawaddy Delta region, alongside our partners in the Myanmar Baptist Convention, the

Figure 4: *Seed production plots at the Kahelu Farm, Irrawaddy Delta Region, Myanmar.*

Figure 5: *Saw Moo Pler (seed bank staff member at the Kahelu Farm) shows off a newly built earthbag seed storage room.*

Figure 6: *Naw Doris (seed bank staff member at the Kahelu Farm) standing next to a newly built seed drying rack.*

initial stages of a seed bank network have begun. Beginning in 2017, several prospective seed bank managers were hosted in Thailand at the ECHO Asia seed bank and trained in all facets of establishing, operating, supplying, and maintaining of a community level seed bank. Upon returning to their respective communities, the first seed banks of the network were established, and have been done in uniquely context appropriate arrangements, using different combinations of innovative options offered by ECHO.

A Look Inside of a Community Level Seed Bank

After spending two months learning the ends and outs of our seedbank operations in Thailand, two of these Managers, Saw Moo Pler and Naw Doris, national staff of the Pathein Myaugmya Association (PMA) in Myanmar, returned to the Kahelu Small Farm Resource Center where they work to establish their own community level seed bank, aimed at serving the surrounding communities with an alternative source of quality seeds.

Figure 7: *A new Community Level Seed Bank being built at the Sustainable Agriculture Training Center outside of Yangon in Myanmar.*

Applying the training received from seed bank staff in Thailand, a modest seed bank 'cold room' was constructed using earthbag building technology, used to lower and stabilize temperature. Raised bed production plots have been planted for growing out seed and supplying the seed bank, and plans are in progress for using local partner farmers to grow out various seed varieties. It was at this site that ECHO Asia hosted a Seed Saving Workshop in January that brought in dozens of local farmers and national development workers, to train on site and learn about seed cleaning techniques, storage technologies, and seed biology. Just six months later, upon returning for a follow-up visit to Kahelu, our staff were amazed at the progress this seed bank had achieved, and were reminded of the power of a good partner; the impact realized by those working in the field, in a community, in relationship, these are the network members we seek to serve.

Staff at the Kahelu Seed Bank have also taken on a research component, helping ECHO to verify and field test some of the practices we promote. A small regional experiment is underway to evaluate the storage conditions of earthbag seed banks, buried clay cisterns, and hillside seed bunkers; all of which are comparing unsealed seeds and vacuum sealed seeds using a modified bicycle pumper vacuum sealer. This 'disaggregated research' is a critical piece in ECHO's ability to provide up-to-date and sound options to our network.

Figure 8: *Boonsong (ECHO Asia staff member) inspects the new earth block seed storage room at the Sustainable Agriculture Training Center.*

Going Forward

The Kahelu seed bank is one example of an emerging network of community level seed banks, and is joined by several additional sites in Myanmar, Cambodia, and the Philippines. Many more exist throughout the region, and it is our hope to help establish, connect, and help build capacity of many more.

Utilizing our new regional seed bank and small farm resource center to train partners, demonstrate innovative options, and experiment with new low-cost techniques will extend our reach beyond what we would have imagined just one year ago. Being equipped to empower our network partners in more impactful ways is what we seek, knowing that it is our partners on ground that will have lasting impact on people's lives, physically and spiritually. Though much progress has been made in the establishment of this new facility, there lies before us so much more! We prayerfully consider each new step and ask that you might do the same, to come behind us and alongside of us, to see to it that ECHO Asia's Small Farm Resource Center and Seed Bank might become a place of great impact.

*Editor's note: Since the writing of this article, the development of the Chiang Mai ECHO Asia Small Farm Resource Center continues to make good progress! We are now offering **tours every Thursday morning** for anyone that wishes to visit our new facility! In addition to tours, we offer consultations and demonstrations of different appropriate technologies.*

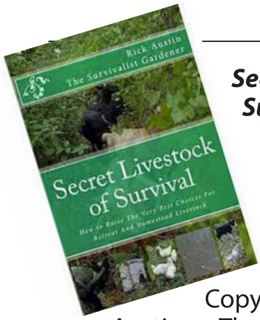
*This site is extremely versatile, also boasting a **conference venue for up to 200 and lodging for 20 persons** (with nearby overflow lodging at another hotel).*

This site is a great opportunity for our network members to use the conference center for events and trainings!

If you or your organization would like more information and pricing, please contact us at echoasia@echonet.org

Book Review: Secret Livestock of Survival

Review by Craig Soderberg



Secret Livestock of Survival by Rick Austin

Reviewed by Craig Soderberg (craigggg@gmail.com)

Rick Austin is a good writer. I read his earlier book, *Secret Garden of Survival*, and I loved it since it was loaded with practical information. In fact, Austin's previous book became the #1 Best Selling Book in the category of Garden Design within 9 months of its release. In his second book, *Secret Livestock of Survival,* Austin not only tells us which livestock he likes to raise and why; he also tells us which livestock is difficult to raise and why it is difficult.

Austin claims that he can raise more food on half an acre than conventional farms do on 5X that space! He feeds his family and livestock from this half acre all year long, without tilling, weeding, watering, fertilizer, pesticide or weed killer. He also gets 1.5 gallons of milk every day from his three small Nigerian Dwarf dairy goats. Austin has also been featured in *Mother Earth News* (3 times), on *National Geographic's* website, in *Newsweek*, on *Doomsday Preppers*, as well as numerous radio shows, TV shows, newspapers, magazines, and internet media.

Austin's *Secret Livestock of Survival* is arranged this way. He puts his livestock recommendations in order of ROI (Return on Investment) as well is in the order of the most discrete animals to raise. For example, the first livestock animal that he discusses is the rabbit because the rabbit is the easiest animal to care for, requires the least effort, the least amount of space and resources, and still gives the owner the most return in food produced.

The rabbit advantage. Chickens take almost half a year (over 5 months) to get 8.5 pounds whereas rabbits take only 2 months to get to 12 pounds. Or to put it another way, in the same amount of time it takes to produce 8.5 pounds of chicken meat, Austin can get 30 pounds of rabbit meat (12 pounds/2 months + 12 pounds/2 months + 6 pounds/1 month = 30 pounds in 5 months). This is one reason that Austin likes rabbits. Secondly, rabbits are quiet, and you can keep them in your barn, basement, or garage, so that no one would know that you had them. Thirdly, rabbits only need about 10 minutes per day of human care (in feeding and watering). Fourthly, rabbits are small enough for a family to consume in one meal, so there is no need for left-overs or for food preservation. Fifthly, rabbit pelts can be used to make various sorts of clothing, from mittens and gloves, to slippers and moccasins. These provide warmth and can be used for barter or sale. Sixth, rabbit bones can be used to make a broth or soup stock.

In the rabbit chapter, Austin gave a great overview of how he converts one pound of barley seed into 13 pounds of livestock feed in just 8 days.

The bee keeping advantage. Honey bees not only provide honey as food, beekeeping provides you with medicine, preservatives, sweeteners, wax products, and even a line of defense for your homestead. Throughout the rest of this chapter, Austin discusses the necessary beekeeping equipment, ways of extracting honey, how to catch swarms of wild bees, how to protect your bees from their enemies, and 10 interesting facts about honey bees that most of us probably did not know.

The duck advantage. Austin likes ducks because they eat bad bugs, slugs, and snails out of his garden and provide a natural substitute to pesticides and chemical fertilizers. Ducks don't scratch up roots like chickens. Ducks are also less susceptible to disease, than most other domestic fowl. Austin created a backyard pond for his ducks; and he raises Pekin ducks for meat and Khaki Campbell ducks for eggs because they produce 320 eggs per duck per year. The rest of his chapter discusses feeding, housing and incubation of the duck eggs.

The goat advantage. Austin prefers dairy goats over meat goats since dairy goats can provide him with milk every day (and various dairy products from that milk). His favorite dairy goat is the Nigerian Dwarf goat because the Nigerians don't require a lot of outdoor space or indoor space, they are quiet, and they don't consume as much feed as other goat species. The rest of the chapter covered goat housing, goat vitamins, goat feed, watering methods, dairy products, fencing, breeding, and raising kids (baby goats).

The fish advantage. I was enlightened by Austin's comparison of establishing a fish pond on the property vs building an aquaponics system. The whole problem with man-made aquaponics ecosystems is that they are not sustainable. First, you have to add food for the fish. So you can either collect bugs, grow bugs, or buy commercial fish food to feed the fish. Second, you need pumps and electricity to move the water, or the whole system doesn't work. In a grid down situation, you won't have power to heat the water or move the water through the pumps. Granted you could use solar power to do this, but that could take a lot of solar energy and the mechanical parts will eventually clog and fail.

So why would someone want to do all this work, create all this infrastructure and make all this investment, when you can just dig a hole in your back yard, and fill it with water and fish? It is far cheaper to dig a hole in your back yard and buy a cheap pond or pool liner and use that pond to house fish that will survive on their own, without any other investment or input on your part. Austin uses edible Koi and edible Goldfish in his pond. But one can also grow other native fish, like catfish. The other advantage of a pond is that Austin's pond holds 11,000 gallons of emergency water storage.

Chickens. Austin does not like chickens. They scratch the roots of plants until the area you keep them in becomes nothing but a desert. Compared to ducks, chickens are bad for garden plants – not good for them. Chickens dig holes everywhere and roosters make a lot of noise. Also hens sound like they are having their feathers pulled out every time they lay an egg. Austin only raises chickens because his wife has a rare allergy for duck eggs. The rest of this chapter discusses feed and water for chickens, chicken breeds, preserving eggs, incubating eggs, fencing and butchering.

Pigs. Austin does not really like pigs. The biggest problem with pigs is the amount of time and number of people it takes to butcher and preserve the meat of just one pig. Unless you have a walk-in commercial freezer, processing a 700-800 pound pig is not something that you and your wife can do over a long period of time.

Austin's conclusions. I liked the fact that Austin told us specifically which animals he would not want to raise. He doesn't recommend cows because of the amount of space and feed required to raise cows. He doesn't recommend turkeys because they are more susceptible to diseases than chickens. He doesn't recommend geese because they are loud and are known to even attack their owners. He doesn't recommend horses because they are not raised for meat, and they require a lot of time and expense to raise them. He doesn't recommend sheep because he does not like the taste of mutton.

Strong points in Austin's book. Throughout his book, Austin provided great color photos and helpful YouTube links. He also provided color photos of other related books that he recommends to his readers. Austin provided a good example to his readers by placing his barn and greenhouse near his home to save time and energy. Austin wisely advised his readers to learn more about trapping wild animals.

Suggested improvements. Austin states that some people have double fencing around their livestock paddocks. But he doesn't state whether or not he follows that practice (p.26.) Although Austin had some great color photos throughout his book, he described the importance of the solid top dropping boards overhanging the rabbit cage but no photos were provided related to this description (p.39). In the chapter on beekeeping, Austin notes that he produces the retail equivalent of over $2,537.00 yearly revenue on a one-time investment of $700 in bee hives. But he did not mention the annual costs of feeding the bees the initial sugar solution that most beekeepers feel is necessary. There were a few spelling errors in the goat chapter (pp.104, 105). But despite a few minor weaknesses, I recommend this book to anyone interested in the topics mentioned above.

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For further information, please visit or send email to:

http://www.goorganics.org/upcoming-event/

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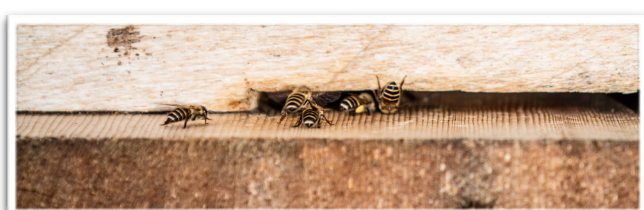
Expected Weather

The cool season in Thailand runs from December to March and North Thailand in general is much cooler. Rainfall in February is expected to be less but being high up in the mountain, local weather can be difficult to predict. Average Temperature during that time may range from 10° C or lower to as high as 24-26° C.

The Workshop

This course will focus on the basics of how to raise the native honeybee (Apis cerena)- Thai "Pheung Prong" which have been raised in Asia for 1000's of years and are very well-adapted and resilient here compared to European honeybees (Apis melifera).

While encouraging the traditional Asian beekeeping methods in many ways, Katrina Klett and her husband He Guoqing, who live in Yunnan, China and have been operating a social enterprise Elevated Honey Co., will be sharing their knowledge in combining the long cultural knowhow of native beekeepers with more modern but simple appropriate technology to increase honey production, quality, and bee health. This have meant better livelihoods for the local



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Call for Articles & Insights

If you are new to the ECHO Asia network, we 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.

1. Please do remember that a "Development Worker" membership entitles you to 10 free trial packets of seed per year! If you would like more seed packets or larger quantities of some seeds (especially green manure/cover crops), we do have additional seed packets and bulk seeds for sale, and our seed bank catalog is available online.
2. Please also know that besides being written in English, our ECHO Asia Notes are translated and available for free download in Thai, Khmer, Burmese, Mandarin, Bahasa Indonesia, Vietnamese, and Hindi languages.
3. 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.
4. If you have never joined us for an event, please consider doing so. There are several events happening in 2019 and we would love for you to join! Please go to the events page of ECHOcommunity.org to learn more.

In addition to using our resources, we strongly encourage you to provide feedback to us in order for us to better know how to serve you and help us to refine our resources and delivery.

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!

Sincerely,

Patrick Trail, M.S., CCA
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