January 2011
Issue 8

ECHO Asia Notes

A Regional Supplement to ECHO Development Notes

ECHO Asia Notes

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Zanthoxylum: A Low-Profile Asian Crop with Great Potential

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Introduction

The genus *Zanthoxylum* (family Rutaceae) contains a fascinating group of plants found around the world from the tropics to temperate zones. With over 200 species, ranging from small shrubs to large trees, *Zanthoxylum* spp. are characterized by sharp thorns on either the stem or leaves. Various *Zanthoxylum* spp. are well recognized as Asian spices, including *Sichuan pepper* or *hua jiao* in China, *sansho* in Japan and *chopi* and *sancho* in Korea (Austin and Felger 2008). In South and Southeast Asia, various parts of

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Figure 1: Zanthoxylum rhetsa tree

Southeast Asia, various parts of *Zanthoxylum* plants are used as a spice in stews, marinades and soups.

Recent literature shows that the anaesthetizing effect of alpha-hydroxy-sanshool, a compound produced by *Zanthoxylum*, has potential as a commercial product to reduce skin irritation. This same compound also induces the numbing sensation experienced by eating certain (central to western) Chinese cuisines containing Sichuan pepper. In South Asia and Africa, *Zanthoxylum* is used in traditional remedies for toothaches, malaria and diarrhoea. A scan of scholarly publications indicates that some scientists are also interested in investigating *Zanthoxylum* spp. as a source of medicinal compounds to be used against major diseases including malaria and diarrhoea.

Two recent studies in northern Thailand have piqued ECHO Asia's interest, since *Zanthoxylum* is an important genus in community-level agroforestry with potential as an under-utilized food source and as an income generator.

Table 1: Zanthoxylum species found around the world. (Morikawa and Burnette, 2006)

Region/Country	Name	Common Name
China, Japan, Korea	Z. *bungeaum*, Z. *piperitum*, Z. *schinofolium*, Z. *simulans*	Sichuan pepper, sansho, sancho, chopi
Thailand	Z. *rhetsa*	Kamchat ton, luuk ra maat, ma khuang
	Z. *nitidum*	Kamchat nuai, nguu hao
	Z. *armatum*	Mak kak
Laos	Z. *rhetsa* or *limonella*	Ma khaen (Indian ivy-rue)

A brief survey of *Zanthoxlum's* food uses in Asia

Commercial spice

Zanthoxylum is well-known as a spice in Asia; people in China, Japan and Korea consume vast amounts. Dominant *Zanthoxylum* species of commerce are native to these countries. According to a 2002 FAO study, China produced 31,000 million tonnes of *Z. bungeaum* fruit for both national consumption and international export. In cases where *Zanthoxylum* fruit is used as a spice, the pericarp or outer casing (in which the shiny black seed is contained) contains the essential oils that provide the intense numbing effect loved by millions.

Hua jiao or Sichuan pepper gives the mouth a characteristic numbing (*ma)* effect that is essential to the sacred duo of *ma la* (numb and hot), found in the fiery stews and soups of Sichuan cuisine in western China. Without the *ma* effect, connoisseurs would consider such food lifeless and flat. As a condiment, *Hua jiao* is mixed with salt to make a spicy dip called *hua jiao yan* and is a mandatory ingredient in the famous "Chinese five spice mixture" found in stores and restaurants (Landis, 2004).

Although called Sichuan pepper, studies indicate that this particular species (*Zanthoxylum piperitum*) may actually be grown only in Japan and Korea rather than China. Of 41 types of *Zanthoxylum* found in China, it appears that *Z. bungeaum* is the only species being used as a condiment.

In Southeast Asia, the predominant *Zanthoxylum* species used for spice are *Z. armatum* (synonym *Z. alatum, Z. planispinum*), *Z. nitidum*, *Z. rhetsa* (synonym *Z. limonella*), *Z. avicennae* and *Z. acanthopodium*. Consumption habits vary between China, Japan and Korea, but the dried pericarp is still used for flavouring stews, soups and meats.

Joshi Tuisum is on the staff of NEICORD, a relief and development organization that works among various ethnic groups in northeast India. He has observed that *Zanthoxylum* products are used throughout that region to spice food. Not only is the ground pericarp used to flavour curries, *Zanthoxlyum* leaves are also cooked with fermented fish and pork. Having seen these products collected in the wild, grown in kitchen gardens and sold in local markets, Joshi reports that depending on the season, bundles of fresh leaves sell for 10 to 30 Indian rupees ($1.00 US currently equals 45 INR).

Figure 2: Zanthoxylum seed and pericarps.

Figure 3: Edible Zanthoxylum leaves.

Zanthoxylum is a ubiquitous spice in Thailand's north, but not as well known in central or southern regions. In northern Thailand, products are used to flavour curries and other dishes, such as *laab khua*, a meat dish. Young shoots, green fruit and dried fruits of *Z. rhetsa* (*ma kwaen* in the Northern Thai dialect*)* are added to food to impart a sweet, lemon-like taste (Chiramongkolgarn and Paisooksantivana 2002). Compared to *hua jiao*, *ma kwaen* doesn't have the same fiery taste. It imparts a smooth citrus flavour to prepared foods, rather than numbing the palate.

Several Northern Thai women interviewed at local markets mentioned that 30 years ago, *ma kwaen* was shared freely among neighbours until farmers began selling the product in the market for 1 baht per kg. Vendors in Chiang Mai's sprawling *Gat Mueang Mai,* a wholesale market supplying local restaurants, state that *ma kwaen* currently sells from 100 to 160 baht per kg in the city, indicating that its economic value has risen considerably. Meanwhile, in the Mae Ai district, three hours north of Chiang Mai city, the spice sells from 60 to 100 baht per kg.

In northern Thailand, *ma kwaen* is typically harvested during the cold season between the months of November and January. In Chiang Mai province, *ma kwaen* farmers and middlemen bring the products from outlying districts to sell to spice vendors in *Gat Mueang Mai*. In Nan province, middlemen buy and repack *ma kwaen* purchased from producers in Laos at bimonthly border markets (Hoare et al. 1997). In a recent conversation with a northern Thai farmer, we learned that the green fruit sells for 30 baht per kg. But if dried (resulting in a product that is 90 percent lighter than the fresh weight) the fruit sells for 100 baht per kg.

Figure 4: Z. rhetsa foilage and fruit

In Laos, *Zanthoxylum* is known as *ma khaen*. It is primarily harvested by women and is a source of cash. As in northern Thailand, the product is used as a spice to flavour meats and soups. A 2001 FAO study stated that *ma khaen* was the fifth most important non-wood forest product gathered in a region northwest of Luang Prabang. However, the reported harvesting method of *Zanthoxylum* in Laos threatens the long term availability of the product, because whole trees are felled to gather the seed pods. The farm gate price (i.e. price of the product at the farm) of dried *ma khaen* is 800 Lao kip per kg ($1.00 US is currently 8060 LAK). The average tree first bears fruit at around 5 to 6 years of age, and yields 5 kg of seeds (FAO, 2001).

Medicinal uses of *Zanthoxylum* spp.

Paresthesia is the mouth-numbing effect believed to be caused by hydroxyl-alpha-sanshool, an alkylamide found in *Zanthoxylum* spp. Anyone who has bitten into a Sichuan pepper can attest to the unique sensation of mild electric shock or "pins and needles" in their mouth. Researchers have likened this experience to that of "touching their tongue to the terminals of a 9-volt battery", which is quite different from the burning pain of chilli peppers or the punch of fresh wasabi.

The numbing and analgesic effects of *Zanthoxylum* have been exploited for centuries as a natural remedy to alleviate acute and chronic pain. In Nigeria, the roots are used as a chewing stick to give a warm and numbing effect. This use is believed to be beneficial to the elderly and to those with sore gums and other oral disease conditions. *Zanthoxylum americanum* is commonly known as toothache tree in North America and can be found in the eastern US as well as Ontario and Quebec in Canada.

Zanthoxylum spp. have traditionally been administered for a variety of maladies in addition to oral diseases. In India, the leaf is used against fever, dyspepsia and bronchitis. In Manipur, India, the seed oil is applied against baldness and bark powder is used to treat toothache (Singh and Singh 2004). In a 2008 report titled "Indigenous Vegetables of India with a Potential for Improving Livelihoods," ML Chadha from the ARVDC Regional Center for South Asia reports that *Z. hamiltonianum* is used as both a vegetable and a remedy; dried, tender leaves are eaten as a vegetable and powdered fruits are consumed to increase the appetite. The young stems are employed as a toothbrush in cases of toothache and bleeding gums, whereas the roots and bark are used to cure malaria. Though generally eaten as a vegetable, the leaves of *Z. rhetsa* are also consumed to kill tapeworms and reduce infection (Chadha 2008).

Scientific studies are validating the traditional medical role of various *Zanthoxylum* products. Research has demonstrated the potential of *Z. rhetsa* leaf extract as a de-worming remedy; it has been found to have a pronounced effect against larval eggs, comparable to a commercial drug (Yadav and Tangpu 2009). Bark extract from *Z. rhetsa* has been shown to lessen abdominal contractions and diarrhoea in mice (Rahman 2002). Other potential pharmaceutical applications include cancer treatment and anti-oxidant, anti-coagulant and anti-bacterial agents.

At the industrial level, *Z. armatum* has been shown to contain high amounts of linalool (Jain et al. 2001), a compound used commercially as a precursor to vitamin E production and also in soaps, detergents and insecticides. Clearly, *Zanthoxylum* spp. have potential beyond traditional uses as spices and folk medicine.

A valuable agroforestry component

In addition to its food and medicinal uses, *Zanthoxylum* has great potential for reforestation (Hau and Corlette 2003, Condit et al 1993) and for intensifying shifting cultivation (Hoare et al 1997).

Zanthoxylum is adapted to a wide range of conditions and can grow in areas as high as 2100 metres (6594 ft.). Boer *et al*. (2004) state that Z. *rhetsa* can grow in ranges up to 500 m (1640 ft.) and can be planted in the open or in shade, although below 400 m (1312 ft.) shade planting is recommended. In northern Thailand, Gardner *et al* (2000) state that the range of Z. *rhetsa* is 800 m (2625 ft.) and higher.

Case study in Nan province, northern Thailand

In 1997, Peter Hoare (then a project coordinator for the Upper Nan Watershed Management Project in Northern Thailand) investigated the potential of *ma kwaen* in intensifying shifting cultivation in priority watershed areas where the Thai government retains land tenure rights but allows the harvest and sale of minor forest products. Nan province, bordering Laos, is one of Thailand's most important river basins. Natural forest destruction in the watershed area has been driven by shifting agriculture, logging and uncontrolled forest fires. Local communities number about 20,000 people among 28 villages. Hoare and his investigators wanted to involve these people in the rehabilitation and protection of forests. One livelihood option for involving locals in forest conservation was through *ma kwaen* cultivation.

Prior to the 1997 study, there was a steady increase in the market price of fresh *ma kwaen*, from $0.10 US per kg to $2.00. The market for *miang*, a local fermented tea, was in decline, and farmers were looking to diversify their agricultural production in other ways. Extended cultivation of *ma kwaen* offered one such alternative. The main benefits from intensified management of fallow land using *ma kwaen* include increased farmer income (especially as *ma kwaen*'s market price increases) and improved fire management in watershed areas. Fire control was expected to improve, because highly valued *ma kwaen* trees are very susceptible to fire damage (p. 616).

Table 2: Yield Data for ma kwaen trees of different ages (Hoare et al. 1997, p. 618)

Age of Trees (years)	Average yield per tree (kg fresh weight)	Average return per tree at USD$2/kg
3-5	2	4
6-10	10	20
11-15	30	60
21-25	50	100

According to local extension information obtained by Hoare and team, the economic benefits of intensified *ma kwaen* production are tremendous. Sales from trees in the 2,164 *rai* (346 ha or 607.9 acre) study area were estimated at $120,000 to $160,000 US. Each 20-year-old tree provided an income of approximately $104 without any cash inputs for agricultural chemicals. Family labour was required only between November and January for harvesting fruit and making firebreaks.

Hoare *et al*. reported that one *rai* (0.16 ha or 0.4 acres) of 6-to 10-year-old *ma kwaen* trees planted at a higher density of 4 x 4 metres would have produced an annual income of USD $2,000 in 1996; this is more than the income generated by one hectare of traditional upland crops of maize and cotton.

According to Hoare and team, in communities where ma kwaen has been planted, fire management has improved since trees are highly susceptible to fire damage; radiant heat from just a few metres away is lethal. In many villages where ma kwaen has been planted, heavy fines have been imposed on farmers who lit fires that damaged trees. One community levies a fine of $4,000 US for every 13 trees killed by fire (p. 617).

Zanthoxylum propagation and establishment challenges

In the past, ma kwaen propagation was simple. Farmers merely gathered seedlings underneath parent trees. Hoare et al. observed another common method of establishing ma kwaen gardens with a large number of trees: many parent trees were planted at the top of a slope so that seeds were spread down slope by birds and soil movement. Seedlings would be established naturally in the slash-and-burn fields below.

They also described attempts to improve the system by burning straw under mature trees, to scarify hard seed coats and to accelerate the usual two-month-long germination period. However, despite efforts to scarify seeds, farmers reportedly experienced losses of young seedlings as high as 60 percent due to heavy rains.

Challenges related to germinating Zanthoxylum seeds and establishing seedlings are widely reported. For instance, as the genus is dioecious (meaning that individual plants are either male or female), both male and female trees must be in close proximity to each other to allow for pollination. Seed production is also challenged if trees are located in shaded areas (Popp and Reinartz, 1988).

Hoare et al. (1997, p. 618) reported that immature seed is often planted, because ma kwaen fruit are harvested when the seed coat is still green. However, germination with immature seeds gives poor results.

In 2005, the Upland Holistic Development Project (UHDP) interviewed farmers in northern Thailand, including ethnic Lahus, Karen and Northern

Thais. Farmers reported that *ma kwaen* germination takes place over a 45-day to 3-month period, during which germinating seeds are subject to predation by ants. One farmer remedied this issue by sowing seeds in tubs and surrounding the basins with rags soaked in diesel fuel to form a barrier against ants.

Figure 5: An ant-proof shelf with legs placed above ground protects the seeds from ant preditation.

Young seedlings are also susceptible to fungal damping off diseases. It is important to control soil moisture during this period in order to avoid high losses of seedlings. Small seedlings are usually transplanted at the two-leaf stage, about a week after germination, using a spoon. At this point, Zanthoxylum roots are very fragile and susceptible to damage, often resulting in high losses (Hoare, et al. p. 618).

Figure 6: Plastic tubs holding germination medium for ma kwaen seed trials at UHDP.

Young transplants are also intolerant of extended periods of high moisture in the field. According to Hoare and team, farmers reported losses of up to 60 percent when seedlings were transplanted in fields during the heavy rains in July and August. In Chiang Mai's Mae Ai district, a woman selling *ma kwaen* in the local market said that for every 10 seedlings planted, only one will survive.

Evidence suggests that losses can be reduced by starting the nursery as early as February and having the seedlings well established before the heavy rains begin [*Ed: Regular watering would be required until the rains begin*.] Alternatively, seedlings can be transplanted into the field at the end of the wet season and watered during the dry season from November to March (Hoare *et al*. p. 619).

Propagation and transplant trials at the Upland Holistic Development Project

Upland Holistic Development Project (UHDP) partnered with Plant with Purpose (http://www.plantwithpurpose.org/) during 2005-2008 to investigate the challenges of intensively propagating *ma kwaen.* The investigation took place at UHDP's Agroforestry and Small Farm Resource Center in Chiang Mai's Mae Ai district. Implementing agriculture and community development work in villages along the Thai-Burma border, UHDP includes a wide range of indigenous non-timber forest product species in its agrofoestry programming.

Z. rhetsa is a native plant grown in northern Thailand, and as such is recognized by UHDP as a natural agroforestry component. Many local ethnic groups use the fruit as a spice in cooking (personal communication, Jamlong Pawkam).

The first set of experimental trials, conducted in 2005-2006, evaluated germination differences of *ma kwaen* seeds harvested at different times. It also looked at the effectiveness of various seed germination treatments and transplantation methods. During 2007-2008, additional trials evaluated the effect of water application and soil moisture on young seedlings in a nursery setting. For each trial, seeds were collected from *ma kwaen* farmers who harvested them from trees over four years of age.

Several key observations were made from the experimental trials:

1. The best germination rates came from fully mature seeds that were freshly harvested in the same season the trials were

conducted. In northern Thailand, the *ma kwaen* harvest usually takes place between October and December when less-mature fruit (with still-green pericarps) are collected. The less-mature fruit are more palatable (and marketable) as they have a stronger, more desirable scent of lemon. More mature seeds are not as aromatic.

From the 2005-2006 trial, the UHDP nursery staff noted that:

- The best germination of seeds (almost 100%) was from fresh post-marketable seeds harvested and propagated between December and January.
- Seeds purchased from the market and/or obtained directly from producers at a marketable stage in November had a much lower germination rate (estimated at less than 70%).
- Seeds kept over from previous years (i.e. 2004) had little or no germination.

2. Seeds soaked in soapy water for 2 hours had better germination rates than seeds soaked in soapy water and then rinsed, or seeds soaked only in water. Our literature searches have encountered references to the use of soapy water to prepare *Zanthoxylum* seeds for germination. However, thus far, we have not come across any plausible scientific explanation that explains why exposure to soapy water effectively improves germination rates.

3. Proper timing and careful handling is needed to maintain the viability of very young *Zanthoxylum* seedlings being transplanted into seedling bags. During the 2006 trial, *ma kwaen* germination rates were so high that only a small portion of seedlings were transplanted, due to time and labour constraints. But during that time, we learned that the optimal period for transplanting new seedlings is when the young plants develop their first true leaves. This occurs about 15 to 30 days after germination, while the seedling root systems are not yet highly developed.

During the trial, 90 percent of seedlings transplanted with two to four true leaves survived 40 days after transplanting, whereas 40 percent of seedlings transplanted with only cotyledons survived. (Cotyledons provide stored energy to seedlings until the first true leaves appear, which have the photosynthetic ability to start producing food for the plant.)

Take care not to destroy delicate roots when removing seedlings from the germination medium and transferring them into nursery bags. Sand is good *ma kwaen* germination medium, because it allows for the easy removal of germinated seedlings. Transplant carefully but quickly; roots exposed to air for too long during movement into nursery bags will dehydrate, thereby reducing seedling viability.

4. To better ensure *Zanthoxylum* seedling survival and vigor, take steps to protect seedling root systems from excessive moisture. During the 2007-2008 trial, *Zanthoxylum* seedlings were transplanted into nursery bags in April (during the hot and dry season) and observed through the rainy season until October, when the rains started to diminish. Seedlings with the best survival rate and tallest average height were those that were placed above ground on a wire mesh platform, hand-watered, and protected from the rain (by clear plastic sheets placed overhead to divert rain water).

After seven months of observation, 51% of these seedlings (with an average height of 24.1 cm) had survived, compared to only 5% of seedlings (average height 12.9 cm) that were placed on the nursery floor but otherwise treated the same. The soil mix of the seedlings that were allowed to sit on the nursery floor drained poorly. *Ma kwaen* is known not to like "wet feet," and the seedlings in contact with the wet nursery floor could not tolerate the near-waterlogged conditions.

Similarly, seedlings that were watered by natural rainfall were subjected to more frequent waterlogged conditions during the rainy season and did not survive past four months after transplanting into nursery bags.

The quality of potting soil is another critical factor to consider. During the trial, the research technician was unable to fill all nursery bags with the same potting soil mix. Some bags were filled with higher proportions of rice husks than others. The healthiest seedlings were found in bags containing soil mix with larger amounts of rice husks, but greater incidence of stunting occurred among seedlings in bags with more clayish soil. Ultimately, a higher proportion of rice husks in the soil mix enabled improved water drainage and healthier *Zanthoxylum* seedlings.

Conclusion

Zanthoxylum spp. is a widely distributed and well-documented genus of plants, with an extensive array of uses and cultural practices throughout the world. *Zanthoxylum* is a popular spice and table condiment in China, Japan and Korea, with dominant native species used for commercial production. In Southeast Asia, the growth of *ma kwaen* markets in northern Thailand and Laos are evidence of the potential of *Zanthoxylum* to be developed as a cash crop. In Africa, the Indian sub-continent and the Americas, interest continues in *Zanthoxylum*'s potential as a source of medicinally important compounds found in all parts of the plant. Few technical documents on specific nursery propagation and field production methods are available. Continued exploration and documentation of intensive *Zanthoxylum* propagation and other cultural practices will enable better employment of this underutilized species as a source of food and income.

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Build Your Own Seed Germination Cabinet for Testing Seed Viability

By Abram J. Bicksler, Ph.D.

Special thanks to Scott Breaden, Phoebe Mbuvi, and Rick and Ellen Burnette

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Introduction and Background

Saving your own seeds is a cost-effective way to access crop seed for future planting and to help maintain the planet's plant biodiversity. Whether you plant your own saved seeds, give them away to friends and neighbors, or distribute them through your organization, knowing the viability of your seeds is important.

Seed viability is a measure of the percentage of seeds that will germinate after storage. The greater the viability of your seeds, the fewer seeds will be needed to establish a desired number of plants in the field or nursery.

Many easy ways exist to test seed viability. A seed germination test is probably the most simple: seeds are given the needed resources (air, water, warmth, and light) to germinate and grow into a seedling. Simply place seeds in the soil or in a pot of soil and see how many grow. However, the problem with using soil, pots, and outdoor resources is that environmental fluctuation exists. This can cast doubt on the true viability of the seeds (did the seeds fail to germinate because they were dead, or because they were watered erratically, fell victim to fungal attack, got too hot, etc.?).

Lower-than-optimum temperatures for germinating certain types of seeds often occur at the ECHO Asia Seed Bank in northern Thailand during the cold season. Outside night time temperatures often dip to 13ºC (55ºF) or lower, and afternoon temperatures rarely rise above 29ºC (85ºF). With cool temperatures complicating certain seed germination trials, the seed bank staff decided that a better way to conduct a seed germination test and reduce uncontrolled variance (forces like irregular watering, fungal spores, temperature fluctuations, etc.) would be to create a dedicated seed germination cabinet where these factors of variance can be moderated.

The seed germination cabinet is now routinely used to test seed viability, and has provided encouraging results. You too can build a low-cost seed germination cabinet to improve seed germination results and to boost your knowledge about the viability of your seed stocks.

Procedures

First you will need a cabinet that can be partially sealed. We purchased a small aluminum kitchen cabinet (122 cm tall, 77 cm wide, and 41 cm deep) from the local furniture store, with two shelves in the uppermost part of the unit and a storage space below (Figure 1).

Figure 1: Finished seed germination cabinet made from a simple aluminum kitchen cabinet

Wood, metal, or plastic cabinets can be used successfully. The cabinet provides a quasi-sealed storage area for maintaining proper temperatures and relative humidity for the germinating seeds (Figure 2).

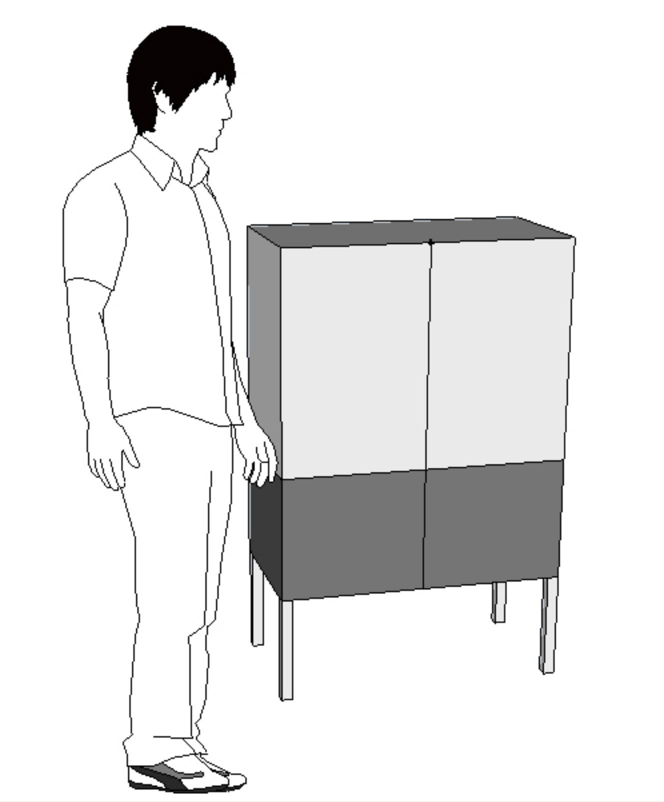

Figure 2: Mock-up of seed germination chamber showing scale of aluminum kitchen cabinet [man is six-feet (1.83m) tall]

Our cabinet had a wire-screen for sides, so we purchased small sheets of insulating foam and covered the inside of the chamber with the foam to reduce heat loss and prevent outside contamination (Figure 3).

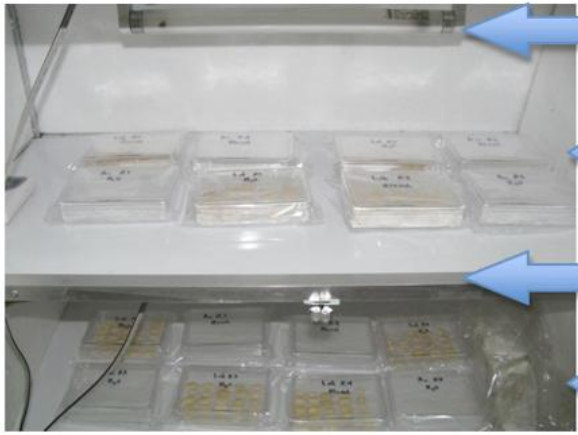

Figure 3: Close-up of 2 shelves used for seed germination, and foam cladding on inside of chamber. A fluorescent tube and ballast hangs from the ceiling of each shelf. Power cords to fluorescent tubes are routed through a hole cut into each shelf into the bottom storage area where the power strip and timer are located.

Because most seeds germinate well with high temperatures and high relative humidity, we also wanted to include a heat source. Using a light source to produce heat can produce light and heat simultaneously in the sealed chamber, while helping to maintain a high relative humidity. We elected to use 2 small horizontal 10W fluorescent T8 (daylight) bulbs that we attached using bolts and nuts via the ballast to the ceiling above each shelf. The cords from each fixture were routed through a hole cut in the shelf below into the bottom storage compartment (we could have easily routed them to the floor or out the side of the cabinet to an outlet). We followed a fluorescent wiring diagram to connect the ballast, starter, tubes, and power supply (Figure 4).

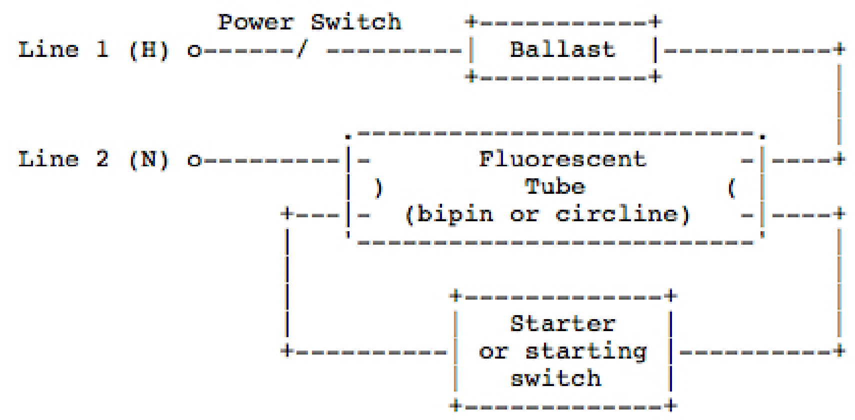

Figure 4: Wiring diagram for a single ballast fluorescent tube (From http://www.repairfaq.org/sam/flamp.htm#int0)

Because leaving the lights on all of the time would add too much heat to the chamber and dry out our seeds, we needed to moderate the lighting so that it shuts off and on to maintain a relatively constant temperature. Therefore, we wired both of the fluorescent fixtures to a 3-outlet power strip that was connected to a wall timer (Figure 5, Figure 6).

Figure 5: Power strip assembly receiving lead-wires from fluorescent tube assemblies.

Figure 6: Timer assembly (connected to power strip in figure 5) to regulate fluorescent tube on/off duration.

Here we needed to do a bit of tweaking: we monitored temperatures in the chamber using a thermometer and adjusted the timer as necessary to maintain as constant a temperature as possible (we found in our conditions that turning the fluorescents on for ½ hour and then off for ½ hour over the course of the day maintained a fairly constant temperature inside of the chamber).

The seed germination cabinet also has many practical and research uses in the field. As part of a USAID-funded HORT CRSP grant with Pennsylvania State University collaborators, ECHO Asia is using a germination cabinet to conduct village-based seed germination studies on locally saved seeds (Figure 7).

Figure 7: Photovoltaic powered germination cabinet in a villager's home for village-based seed germination studies.

Because many remote areas in Southeast Asia are not electrified or lack consistent access to electricity, we have augmented an AC-powered cabinet with a 140W photovoltaic array, deep-cycle battery, and DC-AC inverter to supply the power needs for the fluorescent tubes (Figure 8). The photovoltaic array and battery is enough to power two fluorescent tubes for 12-18 hours per day (depending upon solar radiance).

Figure 8: Photovoltaic assembly and inverter for operating cabinet in non-electrified areas.

Basics of seed germination testing

Once the seed germination cabinet was built, we were free to begin seed germination testing using either: 1) a modified rag-doll test; or 2) a petri dish test. Another *ECHO Asia Notes* article will contain procedures on conducting your own seed germination test. But the gist of the rag-doll test is to place a desired number of seeds on moistened sterile paper towels inside of loosely fitting plastic baggies. These units then go inside the seed germination cabinet and are observed daily for signs of germination; the easiest sign to observe is the emergence of the radicle (the seedling root). [*Ed: For more information about techniques used to measure the viability of seeds, refer to the "Germination and Propagation" section of Chapter 12 of ECHO's "From Amaranth to Zai Holes" which can be accessed via this link: www.echonet.org/content/AtoZChap12/1425*].

Conclusion
With very low financial and labor inputs, a high-quality and highly effective seed germination cabinet can be built from local materials. Its use will more accurately help you to determine the viability of your seeds and the effectiveness of your seed storage techniques. Keep watching for the next issue of *ECHO Asia Notes*, in which we will share how to conduct a simple seed germination test.

Budget
Our total cost for building the seed germination cabinet was: 2,098 baht Thai ($69.13 US). The unit was composed of the following items:

(1) Aluminum kitchen cabinet: 1,300 baht ($42.89)
(2) Fluorescent ballasts and associated wiring: 150 baht ($4.97) per ballast
(2) Fluorescent tubes: 19 baht ($0.65) per tube
(1) 3-prong power strip: 120 baht ($3.75)
(1) Indoor timer: 225 baht ($7.43)
(2) Sheets foam insulation sheeting: 30 baht THB ($1.00)
(1) Tube of epoxy for securing foam to cabinet: 85 baht ($2.82)

2011 ECHO Asia Agriculture and Community Development Conference

October 3-7, 2011

The Empress Hotel

Chiang Mai, Thailand

Online Registration Begins March 1, 2011

Conference Costs:

Package 1 (Single Room): $405 USD

Package 2 (Double Room Sharing): $325 USD

Includes:

- Accommodation for 4 nights
- Daily buffet breakfast, lunch and coffee breaks, Thursday BBQ dinner
- All meetings and post-conference tour
- Roundtrip airport transportation

Package 3 $225 USD

(intended for local residents and excludes accommodation and breakfast):

Confirmed Plenary Speakers:

- Tony Rinaudo, Natural Resource Management Specialist with World Vision
- Dr. Tom Post, CRWRC Team Leader for Asia
- Dr. Arnat Tancho, head of the Soil Resources and Environment Department at Maejo University (Chiang Mai)
- Randy Bevis, founder and director of the Chiang Mai Aquatic Development Farm and regional aquaculture advisor
- Jeff Palmer, Executive Director of Baptist Global Response
- Heather Morris, Technical Advisor for World Concern Myanmar

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- Green manure cover crops
- Aquaculture
- Vermiculture
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