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A Toolkit of Resilient Agricultural Responses to Climatic Challenges in Tropical Asia

by Rick Burnette

During the 2012 ECHO Agriculture Workshop in Yangon, 63 attendees representing at least 25 agriculture and community development organizations from across Myanmar were polled about their observations and opinions related to climate change. The vast majority of the respondents indicated that they were not only aware of climate change, but that they had also noticed change in the local climate or weather patterns. Additionally, 86 percent expressed that they understood that climate change is caused by human activity.

Belief in climate change fluctuates and varies worldwide, with some populations more convinced of change than others. A September 2012 Yale University poll determined that seven in ten Americans (70 percent) believe global warming is happening, while relatively few – only 12 percent – believe it is not. But while overall belief in climate change may be increasing around the world, understanding the roots of its cause appears much more limited. In addition, necessary strategies for adapting to climate change as well as determining approaches to address (or mitigate) its causes are still preliminary.

Meanwhile, climate change is already causing deaths and damaging the global economy. A 2012 study carried out by the DARA Group and the Climate Vulnerable Forum concluded that climate change was already contributing to the deaths of nearly 400,000 people a year and costing the world more than $1.2 trillion US, wiping 1.6 percent annually from the global economy. The impacts were being felt most keenly in developing countries, where damage to agricultural production from extreme weather linked to climate change has been contributing to deaths from malnutrition, poverty and their associated diseases (The Guardian, September 26, 2012). The impacts are expected to worsen over the next two decades (Reuters, September 26, 2012).

Fortunately, farmers, scientists, policy makers and development workers have begun to recognize a wide range of approaches that are needed in the face of increasingly intensified weather extremes. We recognize that there is no single solution for preventing further economic and physical hardship from climate change. However, this article will recommend approaches and technical resources that can mitigate certain agricultural contributions to climate change, as well as those that can enable smallholder farmers in Asia to better adapt their farming to be more resilient to weather extremes.

Climate change and its causes

Climate change refers to any significant change in the measures of climate (e.g., temperature, precipitation, or wind patterns), lasting for an extended period of time, such as several decades or longer (EPA Glossary of Climate Change Terms). Natural causes for climate change include variation in the Earth's orbit, changes in solar activity and volcanic eruptions (EPA; Causes of Climate Change).

However, since the Industrial Era began, humans have had an increasing impact on climate, particularly by adding billions of tons of heat-trapping greenhouse gases (GHG) to the atmosphere. Most of the observed warming since the mid-20th century is due to human-caused greenhouse gas emissions, particularly carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). When the Earth receives energy from the sun, it radiates much of this energy back toward space. However, the greenhouse gases absorb some of the outgoing energy and trap it in the atmosphere, creating the "greenhouse effect" that causes the Earth's atmosphere to hold more heat. This, in turn, is changing the Earth's climate (EPA: Climate change indicators in the United States).

Sources of human-caused greenhouse gases are mainly energy supplies, industry, deforestation, agriculture, transport and buildings (EPA; Global Emissions). However, agriculture is directly respon-

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ECHO Asia Impact Center
PO Box 64
Chiang Mai 50000 Thailand
echoasia@echonet.org
www.ECHOcommunity.org

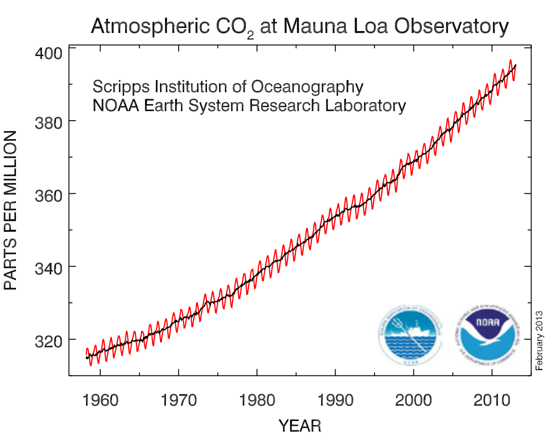
sible for the release of 5100–6100 megatons (Mt) of carbon dioxide equivalents (CO_2e) per year—roughly the same as the world's transport sector—and contributes a disproportionate amount of two high-impact gases, nitrous oxide and methane. According to Charlie Pye-Smith in *Farming's climate smart future*, agricultural practices are responsible for approximately 47 percent of human-generated methane emissions and 58 percent of nitrous oxide emissions.

Agricultural sources of GHG

- The release of nitrous oxide from the soil, largely derived from the breakdown of nitrogen fertilizers, accounting for 38 percent of agricultural emissions.
- Enteric fermentation in livestock that produces large quantities of methane, comprising 32 percent of agricultural emissions.
- Methane from irrigated rice production makes up 11 percent of agricultural GHG emissions.
- Finally, the burning of crop residues and poor manure management constitute 19 percent of agricultural emissions, mostly in the form of nitrous oxide and methane (Pye-Smith).

How much CO_2 is in the atmosphere?

Scientists estimate that at the beginning of the Industrial Revolution, there were approximately 290 parts per million (ppm) of CO_2 in the atmosphere. By 2000, approximately 370 ppm of CO_2 had accumulated in the atmosphere (UNEP/GRID-Arendal). And although scientists say that 350 ppm CO_2 in the atmosphere is safe for humanity, increased GHG emissions meant that by the end of 2012, 392 ppm had accumulated (350 Science).



Monthly mean atmospheric carbon dioxide at Mauna Loa Observatory, Hawaii; 2009–2013 (http://www.esrl.noaa.gov/gmd/ccgg/trends/)

Expected effects of climate change on Asian agriculture

With more than 350 ppm CO_2 in the atmosphere, climatic effects that are now occurring and expected to worsen include:

- Loss of sea ice near the poles.
- Accelerated sea level rise - an additional 33 cm (13 in.) by 2050 on top of the observed rise of 20 cm (8 in.) over the last 50 years.
- Longer, more intense heat waves - the Intergovernmental Panel on Climate Change (IPCC) forecasts a temperature rise of 2.5 to 10 degrees F (1.4-5.6 degrees C) over the next century.
- An MIT study estimates that with every 1 degree C (1.8 degrees F) rise in temperature, tropical regions will see 10 percent heavier rainfall extremes. But even with rainfall increases in the wettest regions, particularly during the rainy season, drier parts of the tropics are expected to become even drier.

Expected impact of climate change on agriculture for the Greater Mekong Subregion

According to a summary report published by the International Water Management Institute (IWMI), the Swedish International Development Agency (SIDA) and the World Fish Center in the Great Mekong Subregion (GMS), the following impacts from climate change can be anticipated in the GMS up through 2050:

- **Increased temperature** - Warmer conditions can prevent pollination and thus reduce yields of crops and pastures. Heat stress when the rice flower is fully open prevents opening of the anther and pollen shed, reducing pollination and grain numbers (Bazzaz and Sombroek). IRRI reports that higher night-time temperatures have reduced rice yields by as much as 10 percent for every 1°C increase in minimum temperature.
- **Increased pests and diseases** - Higher temperatures and longer growing seasons could favor an increase in the population of damaging pests.
- **Increased water demand** - Higher temperatures will increase evapotranspiration, raising the water needs of rainfed and irrigated crops and of pastures.
- **Change in viability of crops** - Changes in temperature and rainfall patterns may require farmers to use new varieties or alter cropping patterns.
- **Vertical shifts in ecosystems** - Average annual temperature decreases by about 1°C for every 100 m (328 ft.) of elevation in tropical to subtropical areas. Some vertical shifts in ecosystems are likely as temperatures rise, particularly on the Tibetan Plateau and in the montane regions of Yunnan.
- **Changes to seasonal timing** - Shifts in both the onset and end of the wet season may affect crop yields and irrigation demand (positively or negatively, depending on the crop calendar).
- **Extreme climate events** – Severe weather is likely to become more frequent.
- **Sea-level rise and saltwater intrusion** - Rising sea waters will reduce viable crop areas in the deltas and along coasts. Saline intrusion already affects 1.4 M ha (3.46 M acres) in the Mekong Delta. Further rises in sea level will require adaptation measures to protect crops.
- **Impacts on fisheries** - Climate changes are likely to negatively affect the availability of many aquatic organisms. Fisheries may dwindle due to reduced dry-season river flows. Changes to wild fish stocks, particularly marine, will affect supplies of fish meal and fish oils that support the aquaculture and livestock industries. However, there may be new opportunities for aquaculture in coastal and delta areas rendered unsuitable for crop production as sea levels rise.

Approaches and resources for adapting agriculture in the face of climate change and mitigating sources of climate change

The following section offers recommended approaches (with links to select online resources) for agricultural development organizations to consider and possibly promote, in order to help smallholder farmers develop resilient agricultural systems and to better mitigate agricultural causes of climate change. Recommended approaches and resources will be offered with regard to:

- Irrigated rice production.
- Dryland crop production.
- Horticultural crop production.
- Livestock production.
- Coastal livelihoods and aquaculture.
- The role of alternative energy in agriculture and community development, as a means of lessening dependence on fossil fuels and improving the use of biomass fuels.

Biological carbon (C) sequestration is perhaps the best way to mitigate agricultural causes of climate change. Biological sequestration transfers C from CO_2 in the atmosphere to biomass through photosynthesis, and ultimately stores it in plants (foliage, wood, and roots) and soils. Agricultural and forest land can be used in various ways to enhance the natural storage of atmospheric CO_2 such as:

- Planting or preserving trees.
- Altering crop production practices.
- Planting vegetation in areas prone to soil erosion.
- Changing the way grazing lands are managed.

When forests, croplands, and grazing lands sequester C, these sites are referred to as **C sinks** (Haile, et al.).

Adapting irrigated rice production to climate change

With higher temperatures negatively affecting rice yields, producers of irrigated rice may need to consider the selection of **alternative planting dates**. Soil moisture permitting, in a hotter environment, farmers should consider possible alternative dates for crop establishment that enable the reproductive and grain filling phases of rice to take place during months with lower temperatures (Redfern, et al.).

Additionally, **access to traditional rice varieties** and **possible new varieties** is recommended. Development workers might consider evaluating and promoting traditional varieties with high resilience, as well as possible new varieties with higher temperature tolerance and with a resistance to salinity, drought and floods (Ibid.). To make both approaches possible, farming communities might be engaged by helping to establish community seed banks, promote household seed saving and/or offer seed fairs so as to survey, conserve and extend traditional rice varieties of potential value. Recommended online ECHO seed saving/seed banking resources include:

- *ECHO Technical Note* #63: "Seed Saving - Steps and Technologies"
- "Testing Seed Viability Using Simple Germination Tests" (*ECHO Asia Notes*)
- "Vacuum Sealing vs. Refrigeration: Which is the most effective way to store seeds?" (*ECHO Asia Notes*)
- "Build Your Own Seed Germination Cabinet for Testing Seed Viability" (*ECHO Asia Notes*)

Additional resources related to seed sharing (seed fairs) include:

- "Seed Fairs: Fostering local seed exchange to support regional biodiversity" (*ECHO Asia Notes*)
- "Farmers' Seed Fairs" (*ECHO Technical Note*)

Here are some appropriate resources related to consulting with agencies (international or governmental) that offer improved new rice varieties, and helping to introduce appropriate crop varieties into farm communities:

- "Climate change-ready rice" (International Rice Research Institute)
- "The Crop Genetic Pump: A Possible Task for NGOs" (*ECHO Asia Notes*)

The **System of Rice Intensification** (**SRI**) holds potential related to both climate change adaptation and mitigation. SRI incorporates the following steps:

- Transplanting seedlings younger than one month.
- Transplanting individual seedlings rather than clumps of three or more.
- Spacing plants widely and regularly rather than densely and irregularly.
- Keeping soils moist rather than flooded.

In response to climate change, SRI is being promoted for the following reasons (Uphoff):

- SRI methods reduce crop consumption of irrigation water.
- Reports of drought tolerance and drought resistance with SRI rice.
- Resistance to storm damage (lodging) and cold temperatures.
- Pest and disease resistance.
- Shorter crop duration (1-3 weeks less).
- Reduced GHG emissions, particularly the reduction of methane; the effect on nitrous oxide levels is still uncertain.

SRI may be evaluated and adopted in part or in whole. Some Cambodian farmers have split their rice fields into two parts, using different management approaches on each to address uncertainty in rainfall, such as planting half of their farm in conventional wet-paddy rice techniques and the other half in less water-intensive SRI cultivation (Redfern, et al.).

The following are useful resources related to SRI, geared toward development workers:

- "SRI, the System of Rice Intensification: Less Can Be More" (*ECHO Development Notes*)
- "Can a Consensus be Reached on the Benefits of SRI?" (*ECHO Development Notes*)
- "Lessons Learned from the Spread of SRI in Cambodia" (*ECHO Asia Notes*)
- "Preparation of Modified Mat Nurseries (MMN) for Improved Rice Seedling Production" (*ECHO Asia Notes*)
- The SRI International Network and Resource Center's (SRI-Rice) SRI Instructional Manuals page offered in various languages

Farmers and development workers should also consider **rotating rice with more drought-resistant crops during drier periods**, especially legumes such as green manure/cover crops (GM/CC). Such an approach may prove a valuable adaptation to limited water resources (Redfern, et al.). Examples of rotating other crops with rice include:

- **Rotation of legumes** such as mung bean (*Vigna radiata*), groundnut (*Arachis hypogaea*) and soybean (*Glycine max*) in the Philippines after two rice croppings (Ibid.).

- Rotation of **GM/CCs** such as sunn hemp (*Crotolaria juncea*), jack bean (*Canavalia ensiformis*), sesbania (*Sesbania rostrata*) and mung bean (*Vigna radiata*) with rice in Thailand. In addition, less thirsty crops such as potato, garlic and onion are often grown in dry season paddy fields.

Resources related to the rotation of various crops with irrigated rice include:

- "*Crotalaria juncea*, a promising green manure crop for the tropics" (*ECHO Asia Notes*)
- "*Sesbania rostrata*: A Green Manure Production System for Rice" – From ECHO's Seed Bank (*ECHO Development Notes* #75, page 7)
- "Soybeans in the Tropics" (*ECHO Development Notes*)

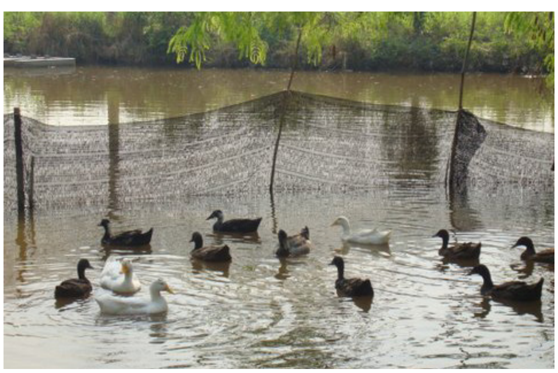
To sequester carbon, rice farmers should stop burning straw in their fields. Instead, they should be encouraged to benefit from such a resource by:

- **Recycling rice straw** in the paddy to build and nourish the soil - see "The Amazing Effects of Rice Straw: Recycling Crop Residues to Improve the Soil" (*ECHO Asia Notes*)
- **Planting second crops**, such as soybean, in the rice stubble - see "Demystifying Soybean Production and Marketing: Our Experience in Laos" (*ECHO Asia Notes*)
- **Using rice straw to mulch other crops** - see "Recycling of Rice Straw – an entry point for sustainable rice production"

Ducks to the rescue

Ducks and rice have had a long association in Asia. The aquatic poultry offer benefits to rice production by eating snails, insect pests and certain weeds, by providing manure and by tilling up the surface of the paddy mud. A study conducted in Guangzhou, China investigating the dynamic emission of methane (CH_4) from a paddy field in a rice-duck farming ecosystem suggested that although the impact of ducks on the emission of CH_4 depended on the rice growth stage and air temperature regime, the introduction of ducks into the rice farming system in general mitigated the overall CH_4 emission and thereby the global warming potential.

During the study, scientists observed that duck activities in the rice fields increased the rate of CH_4 emission during the rice tillering stage but decreased such a rate during the heading stage. Although the exact reasons for such a phenomenon remain unknown, the researchers reasoned that frequent duck movements can accelerate the CH_4 emission into the atmosphere by physically stirring the water of the paddy field. Additionally, such stirring helps to increase CH_4 oxidation by physically increasing the dissolved oxygen concentration in the water of the paddy field, causing decreased rates of CH_4 emission.



For more information, click on the following link to access the related paper:

- http://www.srs.fs.usda.gov/pubs/ja/2011/ja_2011_zhang_003.pdf

See also *The Role of Scavenging Ducks, Duckweed and Fish in Integrated Farming Systems in Vietnam* (FAO document):

- http://www.fao.org/ag/aga/agap/frg/conf96.pdf/men.pdf

Adapting dryland crop production to climate change

Most smallholder farmers in tropical Asia are engaged in dryland crop production. They are particularly vulnerable to less-reliable seasonal rains, frequent drought and land degradation resulting from intensive rainfall.

Approaches related to building resilience in dryland cropping systems and mitigating climate change include **soil conservation** to reduce erosion caused by heavy rain. For related ECHO documents, see:

- "Improving Degraded Land" (*ECHO Best Practices Note*)
- "Vegetative and Agronomic Technologies for Land Husbandry" (*ECHO Development Notes* #89, page 5)

In addition, planting **green manure/cover crops** to prevent soil erosion and to increase organic matter for better retention of soil moisture helps to hedge against the effects of drought. GM/CCs also improve soil condition and fertility as well as offer weed control. Various effective GM/CCs grown in Southeast Asia include lablab bean (*Lablab purpureus*), rice bean (*Vigna umbellata*), cowpea (*Vigna unguiculata*) and jack bean (*Canavalia ensiformis*). For more information, see the following:

- "Sustainable Upland Farming: The Use of Green Manure/Cover Crops for Relay Cropping in the Permanent Hill Fields of Northern Thailand" (ECHO Asia slide presentation)
- "The Use of Green Manure/Cover Crops for Relay Cropping in Northern Thailand" (*ECHO Asia Notes*)

Not burning residues of GM/CCs and other crops will help maintain soil surface coverage and increase the availability of soil-improving organic matter. This will hedge against drought by improving moisture retention and also sequester C (see previous links on managing crop residues).

For resilience in times and areas of drought, grow **drought-tolerant field crops**. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) states that the best way to beat poverty and hunger is to promote drought-tolerant crops on a large scale. ICRISAT's focus is on ground nut (*Arachis hypogaea*), pigeon pea (*Cajanus cajan*), pearl millet (*Pennisetum glaucum*), chickpea (*Cicer arietinum*) and sorghum (*Sorghum bicolor*). Other drought-resistant field crops include cassava (*Manihot esculenta*) and grain amaranth (*Amaranthus cruentus*).

ECHO has resources about various drought-tolerant crops. For example:

- From ECHO's Seed Bank: "Chickpea seeds from ICARDA" (*ECHO Development Notes* #108, page 7)
- "Insights from a simple sorghum trial in Haiti" – From ECHO's Seed Bank (*ECHO Development Notes* #95, page 8)
- "Dryland Farming: Crops and Techniques for Arid Regions" (*ECHO Technical Note*)

- "Increasing the number of cassava tuber roots – Traditional Techniques to Improve Plant Performance" (*ECHO Development Notes* #89, page 2)
- "Amaranth: Grain and Vegetable Types" (*ECHO Technical Note*)
- "Amaranth Potential for the Highlands of Southeast Asia" (*ECHO Asia Notes*)

Where shifting cultivation continues without forest fallows of sufficient length to both improve the soil and sequester C over the long term, **improved short-term fallow systems** using shrubby legumes for sustainable upland rice production is an option. A related resource is *Opportunities for Intensifying Rice-Based Upland Systems* (National Agriculture and Forestry Research Institute publication - Laos).

Expansion of terraced rice paddy fields should be considered wherever possible in the uplands for more secure rice production as contoured paddies harvest rain water. Refer to "The Role of Paddy Rice in the Lao Uplands: Food Security, Farmer Livelihoods, and Economics" (chapter from Proceedings from NAFRI Uplands Workshop on Shifting Cultivation Stablization and Poverty Eradication).

Diversification of rainfed field crops to protect against complete crop failure during weather extremes is extremely important toward building resilience. For example, hill fields in Southeast Asia are often planted with mixtures of upland rice, foxtail millet, sorghum and other crops.

Similarly, crop diversification with **perennial staple crops** should be emphasized. Permaculturist, Eric Toensmeier, states that this group of crops includes "grains, pulses (dry beans), nuts, dry pods, starchy fruits, oilseeds, high-protein leaves, and some more exotic products like starch-filled trunks, sugary palm saps, and aerial tubers." He also emphasizes that perennials can simultaneously sequester carbon, stabilize slopes, and build soils as part of no-till perennial agricultural systems. For more on perennial staple crops, see the following references:

- Toensmeier's *Perennial Staple Crops of the World*
- "Banana, Coconut and Breadfruit" (*ECHO Technical Note*)

Perennials comprise an essential part of all **biodiverse agroforestry systems**. Such systems are much more resilient than annual and perennial crop monocultures (single-species plantations) which, according to Toensmeier, appear to sequester less carbon and are more fragile in the face of pests and extreme weather events. Agroforestry systems that produce various non-timber forest products - also providing biodiversity, productivity, resilience and carbon sequestration – are highly valued in Asia. For more information, see the following:

- "Agroforestry Principles" (*ECHO Technical Note*)
- "Non-Timber Forest Product-Based Agroforestry Systems for Small Upland Farms" (ECHO Asia slide presentation)
- *Indigenous Agroforestry Practices of Northern Laos* (National Agriculture and Forestry Research Institute publication–Laos)
- *NTFP-Based Approaches for Sustainable Upland Development* (National Agriculture and Forestry Research Institute publication - Laos)

Adapting horticulture systems to climate change

Because smallholder horticulture systems are generally intensively farmed vegetable plots or tree orchards of limited size, measures taken in response to climate change can often be more focused and somewhat more readily implemented compared to more extensive farming systems. Recommended approaches for increased resilience, and for climate change mitigation, in smallholder horticultural systems include: 1) diversification with perennials, 2) improving access to water, 3) improving the water holding capacity and drainage of soil, and 4) horticultural approaches for wet or flooded soils.

Diversify with perennials for an uninterrupted supply of vegetables and fruits

In orchards, existing perennials may already be providing drought resilience. However, a stronger emphasis on perennials as a source of fruit, vegetables and other products may require further promotion by agriculture development workers. Deep-rooted, drought tolerant crops require little, if any, irrigation, with many types offering year round production.

Perennial vegetables such as moringa (*Moringa oleifera*), katuk (Sauropus androgynous), red shoot fig (*Ficus virens*), chaya (*Cnidoscolus aconitifolius*), tamarind (*Tamarindus indica*), and climbing acacia (*Acacia pennata*) produce edible leaf shoots. For related online resources, see the following:

- "The Moringa Tree" (*ECHO Technical Note*)
- "Chaya" (*ECHO Technical Note*)
- *Sauropus androgynus* (Katuk) – From ECHO's Seed Bank: "A Nutritious Perennial Green" (*ECHO Development Notes*)
- "Advantages of Perennial Vegetables" (*ECHO Development Notes*)
- "Leaves, Shoots and Hearts: A Guide to Some of Northern Thailand's Perennial Vegetables" (UHDP and ECHO Asia slide presentation)
- "Vegetable Production Throughout the Rainy Season" (*ECHO Asia Notes*)

Fruit that produce year round – Banana (*Musa acuminata*), guava (*Psidium guajava*), papaya (*Carica papaya*), jackfruit (*Artocarpus heterophyllus*) and pomegranate (*Punica granatum*) produce fruit throughout the year. Fruit crops such as these should be used to supplement plantings of seasonal fruit crops for year round nutrition. For basic tropical fruit crop information, see:

- Introducing a New Fruit Crop: An Experience From Central Africa (*ECHO Technical Note*)
- *Fruits of Warm Climates* (the online offering of Julia Morton's classic)

Fruit for increasingly dry zones – Whereas large areas of India and Pakistan are considered either sub-arid or arid with agriculture suited to such conditions, smaller portions of other tropical Asian countries are classified as dry zones, including central Myanmar, northeast Thailand and parts of Indonesia and the Philippines. As dry areas are expected to become even more dry, fruit crops that thrive under arid conditions should be considered, including: desert lime (*Citrus glauca*), fig (*Ficus carica*), dragon fruit (*Hylocereus undatus*), date palm (*Phoenix dactylifera*) and jujube (*Ziziphus mauritiana*). For more information regarding most of these crops see *Fruits of Warm Climates*.

Improving access to water for home gardens to alleviate the effects of drought

Many poor communities across Asia still lack convenient, year-round access to drinking water as well as water for small-scale agriculture and gardening. To make water more readily available, community water development efforts are often great ways to begin collaboration with local stakeholders. Depending on local needs, local resources and finances, community and household water source efforts might include the construction of:

- Community gravity water systems
- Village wells and pumps
- Household and garden rain water collection systems
- Ponds and other reservoirs for water storage

In addition, water access might be extended further through the use of:

- Treadle pumps
- Ram pumps
- Homemade PVC pumps
- Drip irrigation
- Micro-sprinklers
- Careful hand watering with hoses and/or watering cans

Wherever possible, gardens should also be established near **perennially moist locations** such as outdoor laundry and bathing sites that are generally positioned in proximity to village wells, pumps and spigots. Also, placing gardens around natural **seasonally moist sites** (bogs, drainage ditches, gullies and wet-season streams) may help capture lingering moisture and extend vegetable production further into the dry season.

Related online resources include the following:

- *Small Community Water Supplies* (offered by ITACA, an internet appropriate technology collective); this comprehensive PDF covers a vast range of water source topics, including rain water harvesting, spring water tapping, wells and surface water. It also covers water quality and treatment
- *The Anatomy of a Gravity Flow Water System, also offered by ITACA*, is an online photographic guide that details the construction of a gravity flow water system serving 32 families
- Meribah Pumps (associated with the Raintree Foundation based in Thailand) offers plans and other information related to building and installing ram pumps

  Online ECHO documents related to irrigation include the following:

  - "Water Harvesting Through Sand Dams" (*ECHO Development Notes* # 111, page 1)
  - "Gray Water and Crop Irrigation" (*ECHO Development Notes* #88, page 1)
  - "Irrigating With Salty Water" (*ECHO Development Notes* #57, page 4)
- "Deep Pipe and Pot Drip System for Irrigation" (*ECHO Development Notes* #97, pages 3 and 5)
- "Small-Scale Irrigation Efforts in Haiti" (*ECHO Development Notes* #79, page 5)
- "Micro-Scale Water Harvesting" (*ECHO Development Notes* #63, page 1)
- "New Advances in Rope Washer Pumps" (*ECHO Development Notes* #97, page 2)
- "Wick Irrigation" (*ECHO Development Notes* #115, page 4)
- *Hand Dug Wells* – a reference book that can be ordered through ECHO. Click to order.
- PVC Water Pumps (*ECHO Technical Note*)

Improving the water-holding capacity and drainage of soil

Household gardens may be located on soils that are degraded and/or comprised of too much sand, resulting in poor water-holding capacity. Or garden soils may be too clayey, causing poor drainage. The following soil improvement approaches should be considered to ensure sufficient water availability for growing fruit and vegetables.

- **Compost** to maintain soil organic matter for improved soil aeration, water-holding capacity and fertility.
- **Mulch** with locally available materials, such as leaves and rice straw, to conserve soil moisture during dry periods and to keep the soil surface cool.
- Use **raised beds** when and where drainage is a problem.
- Plant crops in **zai holes** (slightly recessed holes enriched with compost) to maximize soil moisture in dry locations with limited access to water.
- **Shade new transplants** from the hot sun.

Online resources related to improving garden soils include:

- *The Handbook of Home Gardening in Cambodia*, a free download from Helen Keller International. This manual is an excellent vegetable gardening resource for tropical Asia, offering practical information on appropriate crops (annual and perennial), compost production and use, and mulching along with other dry season strategies.

ECHO resources that include portions on mulching:

- Roland Bunch's article, "Nutrient Quantity or Nutrient Access?" (*ECHO Development Notes* #74, page 1)
- Dawn Berkelaar's article, "A Successful Approach to Field Cropping in Southern Africa" (*ECHO Development Notes* #98, page 1)
- An article by Danny Blank, "A Fresh Look at Life Below the Surface" (*ECHO Development Notes* # 96, page 11)

Another relevant soil improvement approach to consider is **biochar**, a fine-grained, highly porous charcoal that helps soil retain nutrients and water (International Biochar Initiative). Carbon in biochar resists degradation, reportedly enabling the carbon to be sequestered in soils for hundreds or even thousands of years. ECHO Asia is currently evaluating the effects of biochar in production plots at its seed bank. See the entry from Waiting on the Rainy Season (the ECHO Asia blog), *Preparing for a Biochar Study*. For more information about the production and application of biochar, its effects on soil condition and fertility and its potential for climate change mitigation, refer to these links:

- UBI
- International Biochar Initiative
- "Biochar - An Organic House for Microbes" (*ECHO Asia Notes*)

Horticultural approaches for wet or flooded areas

Floating gardens

For adaptation to climate change in Bangladesh, Practical Action is promoting floating gardens that are built using water hyacinth, which is collected and used to construct floating rafts, eight meters long and one meter wide. Each raft is covered with soil and cow dung on which vegetables (such as gourd, okra and leafy types) are grown. Although a new raft must be built every year, the old one can be retired for use as fertilizer during the dry season. Similar gardens are used to produce vegetables at Myanmar's Inle Lake.

For more information, consult Practical Action's "Floating Garden" page.

Vegetables that grow in moist and flooded areas

Poorly drained, low lying areas are prone to flooding and waterlogging and may be unable to support conventional dryland crops for extended periods. For possible crop production in moist and flooded areas, several Asian aquatic crops might be considered, including:

- Water mimosa (*Neptunia oleracea*). This plant grows in flooded conditions. See "Water Mimosa" (AVDRC).
- Taro (*Colocasia esculenta*). Depending on the variety, this crop will grow in flooded and waterlogged conditions; see *Farm and Forestry Production and Marketing Profile for Taro* (Permanent Agriculture Resources publication).
- Water spinach or kangkong (*Ipomoea aquatica*). Depending on the variety, water spinach will grow in moist, waterlogged or flooded conditions; see "Suggested Cultural Practices for Kangkong" (AVRDC).
- Lotus (*Nelumbo nucifera*). Lotus grows in flooded conditions; a chapter in *Asian Vegetables* (The New Crop Industries Handbook) has lotus production information.
- Watercress (*Nasturtium officinale*). This also grows in flooded conditions; see "Hawaii Watercress Production" (University of Hawaii).
- Vegetable fern (*Diplazium esculentum*). This tropical vegetable fern grows in moist or waterlogged conditions. Unfortunately, very little online production information is available for this crop. For a brief introduction to vegetable fern and other aquatic crops see *Aquatic Crops vs. Organic Soil Subsidence* (Julia F. Morton and George H. Snyder).

The *Handbook of Utilization of Aquatic Plants* (FAO Fisheries Technical Paper No. 187) is an authoritative reference on various aquatic crops grown for consumption by humans and livestock.

Adapting livestock production systems to climate change

Thirty-three percent of the world's cropland is devoted to growing animal feed and 26 percent of ice-free land is used for grazing, according to *Farming's climate-smart future* (Pye-Smith). Livestock production presents a number of challenges in the face of climate change:

- Livestock farming is responsible for overgrazing, land degradation and loss of forests, releasing large quantities of greenhouse gases.
- Livestock are also the largest major source of global methane emissions.
- A significant portion of the annual soybean harvest – much of which is grown on land in Latin America that has been cleared of tropical forests – is used in animal feed.
- Such impacts are expected to increase as meat consumption is forecast to rise dramatically over the coming decades.

A wide range of measures are required to reduce the livestock sector's climate change footprint, including:

- Developing new breeds of ruminants that produce less methane.
- Improving livestock production and feed systems.
- Better grazing management to improve animal nutrition and reduce greenhouse gas emissions.
- Introducing methods of manure management which reduce emissions.
- Integrating livestock and crop production in order to reduce waste and improve soil fertility (Ibid.).

Accessing resilient livestock

Although new breeds of ruminants that produce less methane are not yet a viable reality, access to heat-tolerant breeds of different types of livestock is within the reach of smallholder farmers. To counter the effects of heat on livestock production, Calvosa, et al. (IFAD) recommend strategies that include:

- Identifying and strengthening local breeds that are adapted to local climatic stress and feed sources.
- Improving local genetics through cross-breeding with heat- and disease-tolerant breeds.

Since appropriate genetic resources for increased heat and disease tolerance may include hardy local breeds, NGOs and other development agencies can play a role in inventorying and preserving local livestock biodiversity. If needed, they can help access new, suitable breeds from elsewhere. A resource that introduces strategies for maintaining livestock biodiversity and for improved management and breeding for livestock heat tolerance is "*Climate change and the characterization, breeding and conservation of animal genetic resources"* (FAO slide presentation).

Improvement of livestock production and feeding systems

With increased stress from heat and insect pests (e.g., flies, mosquitoes) expected, improved livestock production practices for smallholder farms might include the **provision of shade and water** (Calvosa, et al.) and **insect exclusion**.

- Shade cloth or similar plastic mesh can be hung around animal facilities, such as pig pens, to block the sun and exclude insects.
- Wood vinegar can be used to repel flies and reduce odor. See "An Introduction to Wood Vinegar" (*ECHO Asia Notes*).
- Water should be available at all times; rainwater harvesting approaches (similar to those listed in the horticulture section) may be applicable.

Related to better feed management, **intensive forage gardens** for "cut and carry" livestock feeding systems can sequester C and be more productive than pastures during hot, dry conditions. To feed goats, cattle and pigs, such gardens may be comprised of locally appropriate forage crops such as: napier grass (*Pennisetum purpureum*), mulberry (*Morus* spp), large indigo (*Indigofera teysmanii*; a multi-purpose nitrogen-fixing tree that provides good fodder for livestock, poultry and some grass fish (Nguyen)), *Leucaeana* spp., fleminga (*Flemingia macrophylla*) and stylo (*Stylosanthes guianensis*). Online forage resources include:

- "Forages" (*ECHO Technical Note*)
- "Mulberry: an exceptional forage available almost worldwide!" (FAO bulletin)
- "Forage crops ease the burden of finding pig feed" (CGIAR article)
- *Managing Feed Resources in Upland Livestock Systems* (National Agriculture and Forestry Research Institute publication–Laos)
- *Forage Options for the Lao Uplands* (National Agriculture and Forestry Research Institute publication - Laos)

Fermenting Livestock Feed

Using perennial, locally-available plant material, such as banana stalks, papaya fruit and other types of fruit and vegetable material, certain types of fermented feed can be used as **supplemental livestock rations** for pigs, poultry and catfish. In response to climate change, such feed made from local herbaceous plants helps to reduce the amount of grains used to raise livestock. Since fermentation does not require cooking, it also saves fuel and reduces the production of GHG.

For an introduction to the use of beneficial microorganisms to produce fermented feed (and also to improve the soil), see the following:

- "An Introduction to Asian Natural Farming" (an ECHO Asia slide presentation)
- "Multiplication and Use of Soil Microorganisms" (*ECHO Development Notes* #110, page 1)

Improved grazing management

Global studies have found that grazing can have either a positive or negative impact on rangeland vegetation and soils (Calvosa, et al.) depending on the:

- Climatic characteristics of rangeland ecosystems
- Grazing history
- Effectiveness of management

For example, according to an International Fund for Agricultural Development (IFAD) report, animal grazing on pasture helps reduce emissions attributable to animal manure storage. The report also states that common grazing management practices that can increase carbon sequestration include:

- **Stocking rate management** – i.e., keep stocking rates from exceeding the grassland's carrying capacity
- **Rotational pasture management** as a cost-effective way to mitigate GHG emissions from feed crop production. Lands in danger of degradation should be fenced off seasonally and/or until they recover.

Introducing grass species and legumes into grazing lands can also enhance carbon storage in soils. According to an International Center for Tropical Agriculture (CIAT) report, sown forage pastures mitigate GHG emissions by:

- **Sequestering atmospheric CO_2.** High quality forages, such as brachiaria, are second only to native forest in terms of their potential for storing soil carbon.
- **Lowering ruminant CH_4 emissions per animal** compared to livestock raised on lower quality rangeland/degraded pasture
- **Reducing N2O emissions.**

Online resources related to improved grazing management include:

- The Living Fence: Its Role on the Small Farm (*ECHO Technical Note*) http://c.ymcdn.com/sites/www.echocommunity.org/resource/collection/D9D576A1-771A-4D95-A889-4FBD9E75D03D/Living_Fence--Its_Role_on_the_Small_Farm.pdf.
- *Forage Development and Management in Communal Grazing System in Malaysia* (FAO document)
- *Improved Pastures under Coconuts in Bicol* (FAO document)
- *Forage Grasses and Legumes with Broad Adaptation for Southeast Asia* (International Grasslands)
- *Tropical Forages: An Interactive Selection Tool* – CSIRO Sustainable Ecosystems (CSIRO), Department of Primary Industries and Fisheries (DPI&F Queensland), Centro Internacional de Agricultura Tropical (CIAT)

and International Livestock Research Institute (ILRI)

A low-input option for improving rangelands is **Farmer Managed Natural Regeneration** (**FMNR**), a rapid, low-cost and easily replicated approach to restoring and improving agricultural, forest and pasture lands. FMNR was originally innovated and promoted in West Africa during the 1980s by agronomist and World Vision worker Tony Rinaudo. The approach has since spread through many corners of the world and is based on encouraging the systematic re-growth of existing trees or self-sown seeds. It can be used wherever there are living tree stumps with the ability to coppice (re-sprout), or seeds in the soil that can germinate.

In arid areas where FMNR has been adopted, grazing animals can make it through a drought even when pasture grasses are completely depleted, by feeding on leaves and pods of trees that have been allowed to grow. Soil fertility on semi-forest pasture also increases, as animals excrete dung and urine while they spend more time in the shade of trees and in search of falling tree pods. The shade of trees in the FMNR system also protects pasture grass and other crops from heat and wind erosion.

For more information, refer to "Farmer Managed Natural Regeneration" (*ECHO Technical Note*).

Managing livestock wastes

Livestock wastes, especially from large production systems, are a source of methane and other pollutants, often contaminating waterways and the water table with nitrates. One option for managing these wastes is through the **production of biogas** using large or small-scale systems. For more information, see the following:

- Heifer International *Biogas* manual (PDF)
- Baron Small-Scale Biogas Digester (link from the Border Green Energy Team website)
- The Livestock Revolution (*ECHO Development Notes* # 76, page 3)

The use of **manure to produce compost** offers another means of C sequestration. For example, natural bedding, such as rice husks or sawdust, will become mixed with livestock wastes after many months of use. Afterward, the nitrogen-rich material can be incorporated into gardens and fields as compost. For information related to appropriate and safe use of animal manures, refer to:

- Manure Management to Prevent Produce Contamination (*ECHO Development Notes* #58, page 3)
- *Recycling Livestock Waste* (FAO publication that covers the use of livestock waste for crop fertilization, biogas production and production of duckweed as an animal feed)
- "An Introduction to Asian Natural Farming" (an ECHO Asia slide presentation)

Adapting coastal livelihoods and aquaculture systems to climate change

According to *Farming's climate-smart future* (Pye-Smith), climate change will have a significant impact on **fisheries and aquaculture**, which currently provide a living for around 500 million people and are the main source of animal protein for many of the world's poorest countries. Some expected results of climate change that will likely affect aquatic productivity are:

- An increase in sea-surface temperature.
- Decreases in sea-ice cover.
- Changes in salinity and acidity.

The report states that the precise impact of climate change on fisheries and aquaculture will vary depending on the regional nature of climate change and the species of aquatic life involved. Some aquatic organisms may benefit from longer growing seasons and faster growth rates, while others may be adversely affected, with significant implications for commercial and subsistence fisheries. For example, cropland in coastal areas impacted by rising sea levels may need to shift from crop production to aquaculture (Pye-Smith).

Due to increased sea water intrusion and more risk of storm surges, the UNDP estimates that crop production in Bangladesh has declined by 30 percent. If sea levels continue to rise at the current rate, 16 percent of the country's coastal areas will be underwater by 2050. An estimated 18.5 million inhabitants of coastal Bangladesh will face hunger, homelessness and poverty as a result of climate change.

In response, the government of Bangladesh is promoting the "**Forest, Fruit and Fish (Triple F)**" project that involves growing fruit and raising fish for livelihood purposes as well as planting mangrove forests. Restoring mangroves and other coastal forests will help to protect coastal land from storm surges, improve wildlife habitats and biodiversity, and sequester C.

Click here for more information about the Triple F project.

For aquaculture to become better adapted to climate change, IWMI and the World Fish Center recommend:

- Integrating fish farming into irrigated agriculture (e.g., fish/rice systems), thereby improving water productivity.
- Improving aquaculture in reservoirs to supplement fish production and reduce pressure on native fisheries.

Because natural fish populations may be increasingly affected by climatic challenges (e.g., flooding, drought), households may find it necessary to produce more fish in **small tanks and ponds**. For smallholder aquaculture resources, see:

- "A Low Resource Method for Raising Fish in Haiti" (*ECHO Development Notes* #105, page 1)
- "Fish Farming: Basics of Raising Tilapia & Implementing Aquaculture Projects" (*ECHO Technical Note*)
- *Farm ponds for water, fish and livelihoods* (FAO document)

Alternative Energy to mitigate against climate change

Development workers can assist smallholders in lessening dependence on GHG-producing carbon fuels through promoting appropriate renewable energy (e.g., solar, hydro) and also promoting technologies that make local biomass fuels (firewood, crop residues, charcoal, etc.) cleaner, more efficient and accessible. In addition to biogas (mentioned previously), alternative energy options for development workers to evaluate and promote include the following:

- **Micro-** or **pico-hydro** that generates electricity from falling water sources, such as mountain streams, using small, relatively inexpensive turbines – See "Micro-hydro in Myanmar and Thailand" (*ECHO Asia Notes*).

- **Solar power**, using energy from the sun to generate electricity and cook as well as to heat water – *Solar Energy, small scale applications in developing countries* (WOT publication on drying and cooking with the sun, hot water and PV panels).

- **Charcoal** produced from waste wood, trimmings and crop residues, that can help prevent/reduce deforestation – "Charcoal Production in 200-Liter Horizontal Drum Kilns" (*ECHO Asia Notes*).
- **Improved charcoal and firewood stoves** that burn fuel more efficiently and with less emissions. See the following resources:
  - "Indoor Air Pollution from Cooking Fire Smoke" (*ECHO Development Notes* #85, page 1)
  - "Portable Clay Stove Construction" (HEDON online resource)
  - "Design Principles for Wood Burning Cookstoves" (The Partnership for Clean Indoor Air)
- **Gasifier stoves** turn biomass, such as rice husks, into synthetic gas that can be used as cooking fuel. The remaining charred biomass can also be used as biochar. Related documents include the following:
  - "Micro-gasification and why it works" (publication for HEDON website)
  - *The comprehensive Rice Husk Gas Stove Handbook* (A.T Belonio)

Final Recommendations

No single solution for adapting food production is comprehensive enough to make farmers resilient to climate change and to mitigate further change. Fortunately, practically all of the options that are recommended here are well known and accepted approaches for sustainable agriculture and community development. However, each development worker or agency should consider the following when investigating appropriate and resilient agricultural responses to climatic challenges for evaluation and possible promotion among focus groups:

- Which climate change adaptation and mitigation responses are most applicable to particular regions and focus communities? For example, certain coastal approaches are probably not appropriate for upland areas.
  - For smaller agencies, focused and specialized responses will probably be a better approach than attempting a wide range of efforts.
  - Agencies should consult with and cooperate with each other to coordinate non-competitive response strategies in shared focus areas.
  - Funding from international donors is increasingly climate change-focused. Agencies should consider how they can best partner with international agencies (and others) to adequately access financial and other resources needed to help build resilient agriculture and communities.

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How to Facilitate Seed Exchanges During Country Meetings or as a Single-Day Event

by Ruth Tshin
Technical Adviser to ECHO

Since 2011, ECHO Asia has developed and facilitated seed exchange events during meetings with local partners. Through conversations with farmers and NGO staff, we have gained better insight about locally-important plant varieties, seed saving practices, attitudes towards saving seeds, and sustainable farming. The most exciting part of these events is hearing success stories! At our first agriculture workshop in Myanmar during November 2012, we were excited when one organization from southern Shan State brought over 75 cuttings of chaya to share with delegates, after having successfully introduced it as a food and forage plant on their small farm resource centre. All of their stock came from a single cutting received only one year earlier during ECHO Asia's biennial Tropical Agriculture conference in Chiang Mai!

In this article, we share our method for implementing seed exchanges that are carried out in the local language and attended by local farmers and development workers. The materials required for a seed exchange are basic, but the actual process of exchanging and capturing information requires prior preparation and an adjustment based on the culture and realities in the particular country.

We recommend reading the article "Seed Fairs: Fostering local seed exchange to support regional biodiversity" (*ECHO Asia Notes* [*AN*] issue 12, January 2012) as it explains the reasons why it is important to build capacity around local plant biodiversity and understand local seed systems. We hope this article helps in your subsequent efforts to implement seed exchange activities in support of those reasons.

Basic materials for exchanging seeds:

- Enough seeds and plant propagation material to share
- Small re-sealable bags in which to distribute seeds
  - In Thailand, we buy small plastic medicine bags from local pharmacies
  - You can easily substitute newspaper or sheets of paper, paper envelopes or bags for plastic bags
- Permanent markers and labels
  - Seed packages should be clearly identified with common and variety names (preferably in local language as well as in English)

Basic materials for the seed exchange facilitator:

- White board or poster paper to list regions or organizations in attendance
- Clipboards, pens and copies of a simple data sheet (Figure 1) for collecting seed information
- Local language translators
- People ready to record seed information

ECHO Asia’s Seed Source information

(Before we place seeds in the seed bank and access them we need the following information. Please take some time to complete the form and provide as much detailed information as possible.)

Seed Source Information	Plant Characteristics
ECHO staff in involved in transfer and Date of Transfer วันที่ย้ายส่งเมล็ด	**Family Name:** ตระกูล **Scientific Name of plant:** ชื่อวิทยาศาสตร์ **Common name** ชื่อสามัญ **Variety** พันธุ์พืช **Description of plant: ลักษณะของพืช** Seed color สีของเมล็ด Features of main parts harvested (pod/fruit/shoots?) ลักษณะเมล็ดที่เก็บเกี่ยว(กลม,ฝัก,ลูก) **Edible?** เป็นอาหารทานได้ **Marketing/Can you sell it?** การตลาด/ขายอย่างไร? **Where are seeds usually planted? In garden? Forest?** ปลูกในสวนครัว?ปลูกในป่า? **What sets this variety apart of other?**ลักษณะพิเศษของพืช? **How does it look/test/cook/store differently from other?** สังเกตโดยวิธีไหน/รสชาติ/ทำอาหาร/การจัดเก็บแตกต่างจากอย่างอื่นอย่างไร?
Source Name ชื่อของบุคคลที่ให้เมล็ด: Source Address: ที่อยู่ของบุคคลที่ให้เมล็ด Source Telephone/Email: เบอร์โทรศัพท์บุคคลที่ให้เมล็ด **The seeds were (circle one):** Free / Purchased _______________(price) ฟรี / ซื้อ เท่าไร _________________ บาท	
Place where seeds originated (village หมู่บ้าน/ district อำเภอ country จังหวัด): **Additional Information on Seed Source:** ข้อมูลเพิ่มเติม	

Figure 1. *An example of ECHO Asia’s biligual data template used for collecting seed source information during seed exchange activities.*

Implementing seed exchange during a multi-day meeting attended by less than 100 people

1. **Well before the event, communicate with and encourage participants to bring seeds and plant propagation material to the meeting.** Include requests for seeds and plant material when you begin advertising the meeting with local organizations. If possible, request each organization to bring a minimum of 500 grams of seed to be able to share with attendees, as well as materials that help explain special characteristics of each species (for example, large colour photographs, seedlings, videos, etc.). Consider also that adequate lead time is needed for delegates to gather seeds and plant materials to share.

2. **Determine whether educational or capacity-building components are required.** The article “Seed Fairs: Fostering local seed exchange to support regional biodiversity” (*AN* 12) has a list of questions to help you decide whether additional discussions should be considered in addition to the seed exchange, including:
    - Are delegates knowledgeable about local crop biodiversity or farmer-produced seed supplies? Are they aware of conditions driving agricultural change in the area? Do they have interactions with the commercial seed industry?
    - Do you need to separate discussion groups into farmers, government agents and development workers?

3. **Decide on parameters of seed exchange.**
    - If you are conducting a multi-day meeting/workshop, consider: 1) which days would be best for collecting seed information, 2) if discussions among delegates are needed, and 3) how to conduct the exchange activity (see below). You may need to set a deadline during the workshop for accepting seeds into the exchange.
    - Consider who should receive seeds. Should delegates receive shared seeds if they did not bring any to share? Or should only delegates who bring seeds participate in the exchange? ECHO Asia typically brings additional seeds for all delegates to receive as a “gift bag” whether they brought any to share or not.
    - Consider the amount of seeds brought to the meeting – there may or may not be enough to share with everyone. Should every delegate from every organization receive seeds? Or should each organization receive only one set of seeds?

4. **Determine method for implementing seed exchange during the meeting.** Meetings that take place over several days are ideal, because it takes time to collect seed information from delegates before the actual exchange. You may need to assign one person to manage and prepare for the exchange apart from regular meeting events. Consider what time constraints you may be faced with, because preparations and the exchange activity may take more time than anticipated. ECHO Asia meetings are usually three days in duration, and we have found the following process to be successful:

    Day 1 – Register the seeds brought by delegates separately from the normal registration process on the first day. ECHO Asia “registers” the seeds in order to compile a master list of varieties shared at our meetings and to record indigenous plant and seed saving information. Typically this process requires translators to ask questions in the local language and people to record information in Thai or English. We have found that simultaneous meeting and seed registration results in confusion, so it is easier to keep these procedures separate. Consider registering seeds after registration is complete or on a separate day as part of the meeting agenda, with a team of translators and recorders dedicated to the task.

- Compile a complete list of seeds brought by delegates. Once a list is completed with delegate names and seeds brought to the meeting, you can continue recording notes and special characteristics for the duration of the meeting. It may be helpful to include delegates’ contact information for future correspondence and future plant evaluations.
- During seed registration, record the special characteristics of seeds to be shared. Use a simple form (Figure 1, Seed Fair Template Form) prepared ahead of time to capture information as efficiently as possible. ECHO Asia tends to take this opportunity to interview

delegates and ask in-depth questions about regional plant varieties and seed systems. You may not need as much information so capture only what you need.

Source of seed

- In what village/district/province/region did these seeds originate?
- Were these seeds produced by an NGO/government agency/farmer/other project?
- Were these seeds propagated by the seed producer?
- Any additional information?

Propagation, usage, and special characteristics

- How did the seed producer propagate the plants? Any special techniques?
- What time of year do you like planting these seeds?
- What parts of the plant do you like to eat? When do you pick the edible parts? How do you cook the edible parts?
  - Can you feed any part of the plant to animals? What parts?
  - Can the plant be used for construction, fuel, agroforestry applications, etc?
  - Are there any other special cultural uses for this plant?
  - Is there a similar plant you also like (to plant, to eat?)
- Describe special characteristics of plant: bushy, vining, drought-resistant, pod and seed colour, etc.
- Are there any specific problems this plant/variety faces?

Production and harvesting

- How did the crop perform in recent seasons?
- Are there specific techniques for harvesting seeds from the plant?

Day 2 – Prepare seeds and plant material for the exchange. Delegates may bring seeds in bulk amounts that then need to be split into smaller portions and into re-sealable bags. For seeds like beans, measure out 10-20 seeds per small bag. For smaller seeds like amaranth or mustard green, measure out 1 tablespoon into the smaller bags. Be prepared for late seed submissions after the registration process is complete. Bags containing seeds should be clearly marked with common and variety name.

- Decide whether to provide time for groups to sell seedlings or bulk seed apart from the exchange activity. We recommend that groups sell their products at the meeting site as a scheduled activity and at a designated area adjacent to the meeting room. A group representative can be given 5 minutes to introduce their goods during public announcements. Each group is responsible for handling receipts and providing exact change. In our experience, allowing seeds or plant material to be sold has not affected the main seed exchange activity.

Day 3 – Implement the actual seed exchange: 45 to 60 minutes total duration. Each organization can be given 5-10 minutes to introduce their seeds and why they are sharing it with the group. Showing actual seedlings and large colour photos of lesser-known plant varieties, and explaining growing and seed harvesting methods and the use of each plant can be helpful in generating discussions. Prepared seed factsheets are also a great way to disseminate information. A time keeper is important to keep this part of the exchange moving along. Following introductions, the exchange activity usually takes 15-30 minutes to complete. However, the exchange format depends on how many delegates are in attendance:

For 40 or fewer people, delegates can gather around a table on which seed packets are displayed and collect as many seed packets as they want.

For 100 or fewer people, calling groups one at a time to collect a limited set (one set of seeds per group) or a designated amount of seeds is most efficient. Groups that brought seeds for exchanging are given priority and are allowed to choose seeds first. Seeds names should be clearly marked and displayed neatly on tables or on the floor.

For our biennial conference of over 100 delegates, a more methodical process is required. We encourage delegates to pre-order seeds and assign a team to manage distribution throughout the duration of the conference.

5. **After the meeting is concluded, review seeds and information collected and assess the exchange event itself.** Was the exchange activity and discussion well received by the delegates? Was the event managed well and was enough seed information collected? What improvements should be considered for future events? Organizations with ongoing presence in the region can follow up on issues and concerns brought up during the exchange. ECHO Asia also collects a sampling of all seeds brought to meetings and evaluates them at our seed bank facility for future use. If your organization maintains a seed bank, you might also want to collect a sample of all seeds present for future dissemination.

Implementing the seed exchange as a single-day event

Seed exchanges can also be facilitated as a stand-alone activity, rather than over the course of several days. The main challenges are: managing time efficiently, having enough people to translate and record, and clearly delegating tasks amongst your team so that the event runs smoothly.

1. **Identify and delegate specific tasks before the event.** It is easy for the activity to devolve into confusion without considering the following roles:
   - Several people to act as translators and recorders, to manage registration and the collection of seed information. Consider having one translator/recorder pair for each group of 5 to 7 attendees, spending no more than 10 minutes per attendee to collect information.

- Several people to help direct attendees towards the registration area especially if the event is attended by many people.
- Several people to distribute re-sealable bags to farmers as soon as they arrive, and to help farmers divide their seeds into smaller lots. Consider distributing bags the day before the exchange activity, with clear instructions to place enough seeds in each bag (depending on seed size; for example, at least 10 to 20 bean seeds or 1 tablespoon of mustard green seeds per bag). This activity should take place separately from the registration area to avoid crowds of people and more efficient activity flow.
- One person to compile the master list of seed information and to write down debrief notes after the activity.
- If necessary, several people to manage food and drinks for the participants. We found that providing refreshments helped maintain everyone's sense of humour when we had exchanges during extremely hot weather! Consider including food and drinks in the event budget and organizing with your local contacts ahead of time, how these will be delivered to the site and distributed during the event.

2. **Create a program with time limits for each activity and announce it at the start of the day.** We found that some farmers lost interest and disappeared if we took too long to complete initial registration. For our single-day events, we started at 8am and finished at 3pm, including a lunch break. Here is a breakdown of how we typically spend the day:
    - Registration, information collection and division of seeds into smaller bags – 60 to 120 minutes
    - Training or educational component, if needed – 45 to 60 minutes
    - Introduction and explanation of seeds provided for the exchange – 60 to 90 minutes
    - Actual seed exchange – 30 to 60 minutes
    - Post-exchange debrief with team – 30 minutes
    - Snack break – 15 minutes; lunch break – 30 to 45 minutes

Conclusion

We want to hear from you! Please send us stories about your successful seed exchange events or lessons learned from not-so-successful events. We also want to know whether or not you have found these guidelines helpful. Email us at echoasia@echonet.org.

Mark Your Calendars!

2013 ECHO Asia Agriculture and Community Development Conference

September 30 – October 4, 2013

The Empress Hotel
Chiang Mai, Thailand

Online Registration Opening in March

Register here!

(http://www.echocommunity.org/?page=Asia_2013Conf)

PLEASE NOTE: At ECHO we are always striving to be more effective. Do you have ideas that could help others, or have you experimented with an idea you read about in *AN*? What did or did not work for you? Please let us know the results!

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