# Promotion of Indigenous Vegetables in Asia: Conservation and Use of Selected Crops in Indonesia, the Philippines, and Taiwan

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## Abstract

**Diversifying crop production and diets combats malnutrition among the poor in developing countries, generates income, and sustains ecosystems under threat due to human intervention. Crop and diet diversification could be achieved by making better use of resilient indigenous vegetables that easily adapt to degraded, drought-prone, flooded, or saline land—areas of which are increasing due to climate change. Despite the recognized importance of indigenous vegetables in alleviating malnutrition and poverty, many remain underutilized due to a lack of information on their use, health benefits, field performance, and input requirements. A lack of varieties or lines for widespread distribution and uncertainty on how these plants can fit into common production systems further curtail their use. AVRDC – The World Vegetable Center currently conducts project activities in collaboration with national partners in Indonesia, the Philippines, and Taiwan to promote the conservation and use of indigenous vegetables. Project activities focus on the rescue, improved conservation, and seed increase of promising lines, variety trials and participatory evaluation of selected accessions, and training personnel in germplasm management. Priority crops differ from country to country. *Ipomoea aquatica* (kangkong, water spinach) and *Moringa oleifera* (Moringa) are described.**

## INTRODUCTION

Asia is rich in agrobiodiversity, housing three out of the eight centers of crop origin as defined by Vavilov (1926): China, India (the entire subcontinent with a related sub-center in Indo-Malaya, including Indonesia, Philippines, etc.), and Central Asia (including northern India, Afghanistan, Turkmenistan, Tajikistan, Kyrgyzstan and Uzbekistan). The crops found in these centers include cereals, fruits and nuts, sugar, drug and fiber plants, root and tuber crops, legumes and vegetables. Indigenous vegetables are native to or originating from a particular region or ecosystem. They may have evolved from materials introduced to the region from another geographical area over a long period of time. Indigenous vegetables are mainly planted in home gardens, or used by a small group of people in a limited geographical area (Engle and Faustino, 2007). Indigenous vegetables have the potential to play a significant role in addressing major factors that affect the quality of life of the poor living in disaster-prone areas of Asia. These factors include low income, malnutrition, loss of biodiversity and loss of resilience of ecosystems

threatened due to human intervention and climate change. Exploring the enormous potential of resilient indigenous vegetables that can withstand harsh growing conditions, such as degraded, drought-prone, flooded, or saline land (de la Peña et al., 2010) could make a significant contribution to crop and diet diversification while minimizing production risks, securing additional sources of farm income, and helping to preserve agricultural biodiversity. Despite the recognized importance of indigenous vegetables to combat malnutrition and poverty, many remain underutilized due to lack of information on their use, associated health benefits, field performance, and input requirements. Furthermore, the lack of tested varieties or lines and the absence of a formal or informal seed sector limit widespread dissemination and cultivation of these valuable plants.

AVRDC – The World Vegetable Center holds a collection of nearly 10,000 accessions of indigenous vegetables originating from South and Southeast Asia, and sub-Saharan Africa. The Center and its regional partners initiated research on regeneration, characterization, evaluation (including micronutrient content and health-promoting properties), and seed production of selected species. Promotional measures included the establishment of school gardens, participatory evaluation, and training for women (Engle and Faustino, 2007). The Center is currently undertaking a project in Indonesia, the Philippines, and Taiwan to promote the conservation and use of indigenous vegetables. Activities focus on collecting endangered indigenous vegetables, improving conservation and seed increase of promising lines, variety trials and participatory evaluation of selected accessions, and training national staff in germplasm management.

## MATERIALS AND METHODS

This paper summarizes project activities undertaken in 2009 and 2010 with the Indonesian Vegetables Research Institute (IVEGRI) in Indonesia, the Bicol Integrated Agricultural Research Center (BIARC) in the Philippines, and the Vegetable Department of the Fengshan Tropical Horticultural Experiment Branch in Kaohsiung, Taiwan. The indigenous vegetables selected by national cooperators for rescue efforts, seed increase, and further promotion differ between countries. Priority crops comprise the following species: *Ipomoea aquatica* (water spinach, kangkong), *Moringa oleifera* (Moringa), *Amaranthus* spp. (amaranth); *Brassica oleracea* var. *alboglabra* (Chinese kale), *Brassica rapa* subsp. *campestris* (edible rape), *Ocimum basilicum* (basil), *Glycine max* (vegetable soybean), *Hibiscus sabdariffa* (roselle), *Basella alba* (Malabar spinach), *Cucurbita moschata* (pumpkin), *Psophocarpus tetragonolobus* (winged bean), *Momordica charantia* (bitter gourd), *Luffa acutangula* (ridged gourd), *Lagenaria siceraria* (bottle gourd), *Benincasa hispida* (wax gourd), and *Trichosanthes cucumerina* (snake gourd). Due to limited space, only two species (*I. aquatica* and *M. oleifera*) were selected for a detailed description based on a literature review. Both have multiple uses and already are grown across a wide geographic area (Asia, the Americas, and Africa); they also have potential for expanded cultivation.

## RESULTS AND DISCUSSSION

### Taiwan: Collecting Missions and Training

Two collecting missions were conducted during the dry season in late 2009 to rescue indigenous vegetables still grown on a small scale in farmers' fields and home gardens in remote communities and to broaden the genetic base of AVRDC's collection. In November 2009, collecting concentrated along the Beinan River in Taitung and

Hualien counties in Eastern Taiwan. A second collecting mission was conducted in December 2009 in the Penghu islands in the Taiwan Strait. A total of 77 accessions comprising 38 genera were collected.

A one-week training course on "Conservation and Germplasm Management of Indigenous Vegetables" was organized by the Genetic Resources and Seed Unit and held from 6-13 December 2009 at AVRDC headquarters in Taiwan to build capacity and create awareness of the importance of conservation and use of indigenous vegetables. The course covered nutritional aspects of indigenous vegetables, guidelines for seed regeneration and quality preservation, seed processing and storage, and documentation. A total of 12 participants from Indonesia (3), the Philippines (3), and Taiwan (6) attended.

Correct taxonomic classification of wild and semi-domesticated vegetable species is often difficult. To strengthen AVRDC's capacity in this field, AVRDC's curator of indigenous vegetables visited the North Central Regional Plant Introduction Station (NCRPIS) of the United States Department of Agriculture / Agricultural Research Service (USDA/ARS) at Iowa State University, Ames, Iowa, USA and the New York Botanical Garden in spring 2010 for training on taxonomic investigations and curatorial methods of amaranth and eggplant species, respectively.

**Indonesia: Adaptation Trials for Selected Indigenous Vegetables**

Previous project activities implemented by AVRDC – The World Vegetable Center from 2003 to 2006 in Indonesia and other countries in Southeast Asia focused on the conservation, evaluation, and use of indigenous vegetables. Farmer- and consumer-participatory evaluations undertaken during the 2004 and 2005 seasons in Indonesia led to the selection of promising accessions of vegetable soybean (*Glycine max*), amaranth (*Amaranthus* spp.), roselle (*Hibiscus sabdariffa*), Malabar spinach (*Basella alba*), hyacinth bean (*Lablab purpureus*), winged bean (*Psophocarpus tetragonolobus*), bitter gourd (*Momordica charantia*), ridged gourd or angled loofah (*Luffa acutangula*), bottle gourd (*Lagenaria siceraria*), wax gourd (*Benincasa hispida*), and snake gourd (*Trichosanthes* spp.).

Based on participatory evaluations involving farmers, traders, and consumers undertaken with the above 11 crops in three locations in the highlands of Cibodas and Lembang, and the lowland of Subang, four indigenous vegetable crops (vegetable soybean, amaranth, roselle, and Malabar spinach) were chosen for distribution to resource-poor farmers to improve their income and combat malnutrition; release is pending per government regulations.

Promising lines of the four crops were regenerated for seed increase during 2009. The same accessions were used for multilocation variety trials during the second half of 2010 (rainy season) under different agroclimatic conditions in three highland locations (Lembang, Garut, and Cipanas). The trials comprised 11 lines and one control variety of vegetable soybean, 15 lines and two control varieties of amaranth, and three lines each plus one control variety of roselle and Malabar spinach. The candidate lines were evaluated for their commercial value and eventual superiority over the control varieties included in the trials to be eligible for later variety release.

**Philippines: Community-based Conservation and Multiplication of Selected Indigenous Vegetables**

To promote the role of indigenous vegetables for improved nutrition and diversified farm income among farming communities, a community-based seed system

for promising indigenous vegetables was initiated in 2009 in the Bicol region at Hanawan, Ocampo, Camarines Sur. The project focuses on seed conservation and multiplication to ensure the availability of good quality seeds for home gardens and commercial production. Integrated pest management practices are used for the control of disease and insect pests, and fruit is harvested at full maturity to assure good seed quality. Several lines of jute mallow, cucumber, bottle gourd, eggplant, and ridged gourd have undergone seed increase with seed yields ranging from 50 to 790 g. Seed samples of these lines were distributed to other agricultural research centers, farmers' organizations and individual farmers.

**Two Indigenous Vegetables with Multiple Uses and Worldwide Relevance**

**1. *Ipomoea aquatica* – kangkong, water spinach, or water convolvulus.** Some 400 species make up the genus *Ipomoea*, out of which *I. batatas* (sweet potato) is the most economically important species. According to the species name, *I. aquatica* is associated with wetlands (Austin, 2007) and grows wild in canals, lakes, ponds, rivers, marshes and rice paddies. Two basic wild forms of *I. aquatica* are recognized: (1) a red form with red-purple stems, dark green leaves and petioles, and pink to lilac flowers; and (2) a white form with green stems, green leaves with green/white petioles, and white flowers (Harwood and Sytsma, 2003). *I. aquatica* primarily reproduces through vegetative fragmentation (Edie and Ho, 1969), but also spreads by sexual means, one plant producing up to 245 fruits (Patnaik, 1976) that are likely adapted for water dispersal (Austin, 2007).

Wetland and dryland systems are used to cultivate kangkong (Edie and Ho, 1969). In the wetland system, the field is flooded to a depth of 3-5 cm and the soil trampled before planting the cuttings 40 cm apart. As the crop grows, the water level is increased to 15-20 cm. The first harvest can be made about 30 days from planting, with subsequent harvests every 7-10 days. Up to 10 harvests are possible in one season with an accumulative annual yield of 90 t/ha (Edie and Ho, 1969). The white stem form is preferred in wetland cultivation. In contrast, for dryland production the small and hardy, but less productive red stem form is preferred (Edie and Ho, 1969). Maturity is reached 45-60 days after planting.

Kangkong is a popular leafy vegetable in Southeast Asia and southern China. Numerous common names are used for this crop (Austin, 2007). It was first reported as a cultivated vegetable in China around 300 CE (Common Era) during the Chin Dynasty (Edie and Ho, 1969), but could date back to 200 BCE (Before the Common Era) (Austin, 2007). It is now widespread throughout South and Southeast Asia, tropical Africa, South and Central America, and Oceania. This highly nutritious leafy vegetable rich in protein, calcium, provitamin A and vitamin C can be considered for protected cultivation in temperate regions (Pinker at al., 2007). The tender shoots and leaves with petioles are used fresh as salad, or steamed, boiled, or stir-fried (Lin et al., 2009). Kangkong also is used as feed for pigs, cattle, and fish (Edie and Ho, 1969). Leaf preparations of this crop are beneficial for treating gastric and intestinal disorders (Patnaik, 1976).

Another quite different non-food use of *I. aquatica* is for phytoremediation to safeguard the environment. In Nigeria, constructed wetlands using *I. aquatica* were shown to be effective in treating polluting leachate emanating from solid waste landfills (Aluko and Sridhar, 2005). *I. aquatica* has also been tested for nitrogen removal from eutrophic water (Li et al., 2007) and transgenic lines of this species accumulated sulfate from waste water at rates 5-fold higher than control lines (Jomkhwan et al., 2006).

As masses of *I. aquatica* may obstruct water flow in drainage and flood control canals, it was listed as a noxious weed in 35 U.S. states (USDA, 2006). Although the species has become a problem in Florida and possession of the plant is prohibited there, (Harwood and Sytsma, 2003), kangkong continues to be grown in Texas, the U.S. Virgin Islands, and California, with the latter accounting for 90% of U.S. production.

**2. *Moringa oleifera* – Moringa, drumstick or horseradish tree.** The small monogeneric Moringaceae family comprises 13 species that, according to the results of PhD research undertaken by Mark Olson at Missouri Botanical Garden (Olson, 2010), fit into three broad life forms with distinct geographic locations. Four species belong to the group of bottle trees with bloated water-storing trunks: *M. drouhardii* (Madagascar), *M. hildebrandtii* (Madagascar), *M. ovalifolia* (Namibia and southwest Angola), and *M. stenopetala* (Kenya and Ethiopia). Three Moringa species are characterized by slender trees with a tuberous juvenile stage: *M. concanensis* (India), *M. oleifera* (India), and *M. peregrina* (Red Sea, Arabia, Horn of Africa). Six tuberous Moringa tree, shrub, and herb species are found in northeast Africa: *M. arborea* (northeast Kenya), *M. borziana* (Kenya and Somalia), *M. longituba* (Kenya, Ethiopia, Somalia), *M. pygmaea* (northern Somalia), *M. rivae* (Kenya and Ethiopia), and *M. ruspoliana* (Kenya, Ethiopia, Somalia).

*M. oleifera* is the most widely cultivated species of the Moringaceae family. It is a perennial softwood tree native to the sub-Himalayan ranges of India, Pakistan, Bangladesh and Afghanistan (Fahey, 2005). It is widely grown in the tropics of Asia, Latin America, the Caribbean, Florida and the Pacific Islands to West, East, and South Africa. Moringa already is an important crop in India, the Philippines, Ethiopia, and Sudan (Fahey, 2005). It is an exceptionally nutritious vegetable tree with multiple uses and beneficial properties and has therefore been called a "miracle tree" (Fuglie, 1999) or "one of the world's most useful trees" (Lea, 2010).

*Food Uses.* Most parts of the tree are edible. The leaves are eaten as salad, as cooked vegetables, or added to soups and sauces (Duke, 1983). Flowers are consumed as cooked vegetables, added to sauces, or used to make tea (Bosch, 2004). In Sudan, flowers are crushed and then fried. In Asia, the tender pods are highly valued as a vegetable and also are pickled (Ramachandran et al., 1980). Fried seeds taste like groundnuts (Ramachandran et al., 1980; Polprasid, 1996). The root bark has the pungent taste of horseradish (*Armoracia rusticana*) and is used as a condiment. Dried leaf powder has been recommended in developing countries to supplement diets of children and pregnant and lactating women (Bosch, 2004).

Among 120 species of Asian indigenous vegetables tested for nutrient contents, antioxidant activities (AOA), and indigenous knowledge of their medicinal uses, *M. oleifera* is among the most promising species according to Yang and co-workers (2006). Four Moringa species tested revealed high antioxidant activity, high antioxidant and nutrient content, and low antinutrient oxalate content. Boiling in water enhanced aqueous AOA and increased bioavailable iron (Yang et al., 2006). Monica Marcu (2005), author of the book *The Miracle Tree*, describes this tree as follows: "In comparable amounts (gram per gram), Moringa contains four times more vitamin C than oranges, three times the iron of spinach, and four times the calcium found in milk! Vitamins B1, B2, E, and pro-vitamin A are also present in quantities that make oranges or carrots pale by comparison. Other vitamins and micro- or macroelements (such as selenium, manganese, sulfur, magnesium, potassium, and copper) are found in Moringa." In addition, all essential

amino acids are found in this vegetable tree in favorable proportions and comparable amounts as in soybean (Marcu, 2005).

*Agronomic and Horticultural Uses.* Moringa can be planted as a windbreak or living fence (Jahn et al., 1986). The tree has potential in alley cropping and as a component of agroforestry systems for sustainable vegetable production (Palada, 1996). In some parts of Southeast Asia the tree is used as support for climbers such as yams, beans, and black pepper. The leaves and twigs serve as livestock forage (Polprasid, 1996; Bosch, 2004). Moringa is grown as an ornamental tree in Latin America, the United States, and Africa (Jahn et al., 1986).

*Industrial Uses.* Moringa seed contains about 40% oil. Known as ben oil, it is non-drying, resists rancidity, and is used in cooking, for lubrication, and in the cosmetic industry (Duke, 1983). The leftover press cake or ground Moringa seeds are used to flocculate contaminants and purify drinking water (Bosch, 2004; Fahey, 2005, Lea, 2010). The wood yields a blue dye (Duke, 1983) and a coarse fiber, suitable for making mats, cordage, and paper (Polprasid, 1996). A survey conducted in India on 75 indigenous plant-derived oils revealed that *M. oleifera* has good potential for biodiesel production (Azam et al., 2005). This was confirmed in a specific study using *M. oleifera* seeds from Pakistan (Rashid et al., 2008). Biodiesel obtained from Moringa oil showed a high cetane number of 67, one of the highest found for a biodiesel fuel.

*Medicinal Uses.* The Moringa family is rich in glucosinolates and isothiocyanates (Fahey et al., 2001; Bennett et al., 2003), which are important constituents of medicinal preparations of this plant. A recent analysis of the glucosinolate content of four Moringa species maintained in the AVRDC field genebank, revealed that *M. oleifera* had a 3-fold higher glucosinolate concentration than *M. stenopetala,* ranking second among the four species tested (C. Ulrichs, pers. comm.).

Dietary or topical administration of Moringa preparations (e.g. extracts, decoctions, creams, oils, powders, porridges) have been reported in the scientific literature as having antibiotic, antitrypanosomal, hypotensive, antispasmodic, antiulcer, anti-inflammatory, hypo-cholesterolemic, and hypoglycemic activities (Fahey, 2005). Moringa powder has been recommended as an immune stimulant in HIV/AIDS supportive treatment (Burger et al., 2002). Moringa flowers, leaves, and roots are used in traditional folk medicine for the treatment of various tumors, and the seeds are used for abdominal tumors (Hartwell, 1982). A dramatic reduction in skin papillomas was demonstrated following ingestion of Moringa seedpod extracts (Bharali et al., 2003).

This fast-growing tree grows well in hot, semi-arid regions with as little as 500 mm annual rainfall (Bosch, 2004), but also does well under wet and seasonal conditions (Polprasid, 1996). In general, Moringa grows best in lowland cultivation, but it also adapts to altitudes above 2000 m. Given its wide range of adaptability, it is a resilient tree, capable of adapting to climate change.

Greater use of Moringa can make a huge impact in the fight against hunger and malnutrition in the developing world by improving the health of the rural and urban poor, increasing incomes of smallholder farmers, controlling soil and wind erosion, and providing shade and clean water. Its wide range of adaptation makes it an ideal crop to thrive as the climate changes.

## CONCLUSIONS

The training of national partners in germplasm and genebank management including the correct taxonomic classification of the vast range of indigenous vegetable

species filled knowledge gaps and helped strengthen the confidence of staff dealing with curatorial issues. Multilocation trials of promising indigenous vegetable lines in Indonesia during the dry and rainy season are mandatory for official variety release before selected lines can be distributed to farmers. To promote the role of indigenous vegetables for improved nutrition and diversified farm income, a community-based seed system for the conservation and multiplication of selected indigenous vegetables has been implemented in the Philippines and seed distribution to interested farmers has already started. Kangkong and Moringa are important leafy vegetables in Asia as well as in other regions, and the latter is reputed to be one of the world's most useful trees.

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