Less visible but yet vital for human health: Nutrient-dense indigenous vegetables and their need for urgent promotion in balanced diets[20]

JDH Keatinge[21], RJ Holmer[22], AW Ebert[23] and Jd'A Hughes[24]

This paper describes the importance of indigenous vegetables in traditional food systems with a particular focus on Southeast Asia. Many indigenous vegetables are nutrient dense, may require only low external inputs and currently cope well with abiotic and biotic stresses if grown on a small-scale and in mixed cropping systems. To ensure the food and nutritional security of current and future generations it is an imperative to collect and conserve the full diversity of indigenous vegetable species and other important food crops. AVRDC – The World Vegetable Center's genebank holds close to 60 000 accessions of vegetable germplasm out of which 12 000 accessions belong to some 200 species of indigenous vegetables which have recognized potential for incorporation into resilient cropping systems. Despite the known importance of indigenous vegetables in alleviating malnutrition and poverty, many remain underexploited due to a lack of information on their use, health benefits, field performance, input requirements and marketing potential. A lack of cultivars or lines for widespread distribution and uncertainty about how these plants can fit into common production systems further curtail their use. Project activities of AVRDC – The World Vegetable Center and its partners focus on the rescue, improved conservation, and seed increase of promising lines, cultivar trials and participatory evaluation of selected accessions, and capacity building in germplasm management. Limited investment in research and development in vegetables, particularly indigenous ones, is a constraining factor in further harnessing their potential for sustainable development.

Keywords: Plans Species, nutritional value of indigenous vegetables, agricultural biodiversity and indigenous and traditional food systems

Introduction

Worldwide, 1 500 to 2 000 plant species have been used as vegetables; for Southeast Asia, close to 1 000 species with uses as vegetables are known (Siemonsma and Piluek, 1994). Out of the latter, about 120 species are cultivated commercially or used for home consumption. The term 'indigenous vegetables' primarily refers to plants grown in their centers of origin or diversity (Vavilov, 1926), but also encompasses plant species introduced from other geographical areas that have adapted well to the new environment (Lin et al., 2009). In many cases, these plants naturalized and evolved in the new environment. *Cosmos caudatus* (cosmos) and *Limnocharis flava* (sawah lettuce, velvetleaf) are examples of crops introduced from South and Central America to Southeast Asia (Siemonsma and Piluek, 1994) as part of the great transmigration of plants that followed the voyages of Christopher Columbus to the Americas, which had an enormous impact on agriculture and food systems all over the world.

[20] Paper presented at the Regional Symposium "Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific", 31 May – 2 June 2012, Khon Kaen, Thailand.

"Promotion of underutilized indigenous food resources for food security and nutrition in Asia and the Pacific".

[21] Director General, AVRDC – Shanhua, Tainan, Taiwan; email: dyno.keatinge@worldveg.org

[22] Regional Director East and Southeast Asia, AVRDC, Bangkok, Thailand.

[23] Head, Genetic Resources and Seed Unit, AVRDC, Shanhua, Tainan, Taiwan.

[24] Deputy Director General – Research, AVRDC, Shanhua, Tainan, Taiwan.

Some indigenous vegetables are grown throughout Southeast Asia, with multiple uses and significant economic potential such as *Moringa oleifera* (Moringa, horseradish tree) and *Ipomoea aquatica* (kangkong, water spinach) (Ebert, 2011a; Ebert, 2011b). Others are only known to, and used by, a small group of people in a limited geographical area and mainly planted in home gardens or on a small scale (Engle and Faustino, 2007). While modern, globally used cultivars of standard vegetable crops often suffer when exposed to biotic and abiotic stresses, many indigenous vegetable species, being well-adapted to local agroecological conditions, are hardy and able to tolerate harsher and more difficult environments, often due to their short growth cycle (Maurya et al. 2007). Many indigenous vegetables may require fewer production inputs and do not yet have recognized pest and or disease problems as long as they are planted on a small scale and in mixed cropping systems and thus may not require pesticide applications. Therefore, underutilized, indigenous vegetable crops are important for diversification of production systems and may create less environmental pressure than standard crops.

Nutritional value of indigenous vegetables

As well as fruits, vegetables make a major contribution towards more balanced diets worldwide by providing much needed micronutrients and vitamins on one hand and ensuring variety and good taste in many otherwise bland staple dishes on the other. Some vegetables are known and grown globally—such as tomato, cabbage, cucumber, and carrot. There are many different universal cultivars of these crops available, with the produce coming in different colors and shapes, and with different qualities and uses. Unfortunately, plant breeders have to abide by the preferences of the important players along the value chain of the produce and often sacrifice taste and beneficial nutritional content for improved yield, disease and pest resistance, size, uniformity and extended shelf life. In contrast, many indigenous vegetables which are much less in the focus of breeders and traders, often have a much higher micronutrient content than the well known global vegetables such as tomato and cabbage (Table 1). AVRDC has collected more than 150 species of indigenous vegetables from Asia and Africa and evaluated their nutritional value. Many species are high in either one or several micronutrients including vitamins A, C, E, folates, iron, calcium and antioxidants (Yang et al. 2006; Yang et al. 2007; Yang et al. 2008; Yang and Keding 2009). Although often underutilized --- indigenous vegetables have the potential to play a significant role in addressing several of the United Nation's Millennium Development Goals, such as hunger and malnutrition, child and maternal health, poverty and loss of biodiversity. All such factors affect the quality of life of the resource-poor living in disaster-prone areas of Asia and other parts of the world.

It has been suggested that perhaps the absence of breeding and 'crop improvement' might be the reason for the high nutritional value of mostly untouched local fruits and indigenous vegetables and this has inspired a scientific consortium to identify 'pre-domesticated' varieties of crops (mainly fruits and vegetables), which might contain significantly higher levels of nutrients than the varieties currently used for food production (Unilever, 2012).

Table 1. Micronutrient content of common and indigenous vegetables

Nutrient content	Range	Tomato	Cabbage	Moringa	Amaranth	Slippery cabbage	Sweet potato leaf
ß-carotene (mg)	0.0 - 22	0.40	0.00	15.28	9.23	5.11	6.82
Vit C (mg)	1.1 - 353	19	22	459	113	82	81
Vit E (mg)	0.0 - 71	1.16	0.05	25.25	3.44	4.51	4.69
Iron (mg)	0.2 – 26	0.54	0.30	10.09	5.54	1.40	1.88
Folates (mg)	2.8 – 175	5	ND[1]	93	78	177	39
Antioxidant activity (TE[2])	0.6 - 82,000	323	496	2858	394	560	870

[1] Not determined
[2] TE = trolox equivalent (mM TE/g FM
Source: AVRDC

Table 2. Percentage of recommended nutrient intake (RNI) for pregnant women during the first trimester, contributed by 100 g fresh weight of each of six indigenous vegetable crops

	% of RNI* contributed by 100 g fresh weight						
	Protein	Vitamin A	Iron	Folate	Zinc	Calcium	Vitamin E
Slippery cabbage	6	106	5	30-177	11	18	58
Moringa leaves	7	146	11	49	5	10	65
Amaranth	9	160	6	31	6	32	17
Jute mallow	10	198	12	21	0	36	36
Nightshade	8	101	13	10	9	21	28
Cowpea leaves	8	193	6	27	3	54	101

* RNI for pregnant women (1st trimester: protein 60 g, vitamin A 800 µg retinol equivalent (RE), iron 30 mg, folate 600 µg, zinc 11 mg, calcium 1,000 mg, vitamin E 7.5 mg alpha-tocopherol equivalents (a-TE); WHO/FAO, 2004)

Source: Hughes and Ebert, 2012.

Constraints to a wider use of nutrient-dense vegetables

Despite the potentially significant role of indigenous vegetables in achieving food and nutritional security, constraints to their production and consumption still leaves them on the margins of agriculture. This lack of competitiveness is largely due to underinvestment in research and development efforts for their improvement (Javier, 1993). The scientific community can contribute substantially to the drive to move indigenous vegetables into the mainstream of important food crops. Scientific gatherings such as the "2nd International

Symposium on Underutilised Plant Species" held under the motto 'Crops for the Future – Beyond Food Security' in mid-2011 in Kuala Lumpur, Malaysia, contribute toward this goal. Mainstreaming agricultural biodiversity and indigenous and traditional food systems are again in the focus in 2012 as evidenced by this Regional Symposium on "Indigenous and traditional food systems of Asia and the Pacific" organized by the Food and Agriculture Organization of the United Nations together with Khon Kaen University, Thailand and the Thailand National Research Council as well as the forthcoming 1st Regional Conference on "Agrobiodiversity Conservation and Sustainable Utilization" which will be held in September 2012 in Langkawi, Kedah, Malaysia.

By preserving and utilizing biodiversity to select and breed superior varieties whilst retaining or improving their nutritional content, by sustaining and promoting the availability of high quality seeds, by enhancing the traditional knowledge of production through improved cultivation practices, by advocating the benefits of consumption, and by improving food preparation methods for increased nutrient bioavailability and intake -- research and development efforts can contribute to more rapid progress towards achieving food and nutritional security worldwide.

Conservation of the genetic diversity of vegetables, in particular indigenous vegetables

Indigenous vegetables are a very diverse group of crops that includes many different species. Their genetic biodiversity is a cornucopia of promising desired characteristics, especially concerning nutrient density, which have yet to be mined. Priorities set by governmental policies often focus on the more well-known, commercially important vegetable species, neglecting the less well-known, indigenous vegetables. If there is no conscious effort to conserve indigenous vegetable biodiversity, and if the predicted shifts of global agroecological conditions due to climate change and variability materialize, the diversity of less well-known but versatile and valuable indigenous vegetables will be eroded and many species may face extinction. According to a recent study conducted by scientists of the Royal Botanic Gardens, Kew, the Natural History Museum, London and the International Union for the Conservation of Nature (IUCN) one fifth of all plant species on earth face extinction (Hill, 2010). Therefore, it is imperative to collect and conserve the diversity of indigenous vegetable species and other important crops to ensure the food and nutritional security of current and future generations.

AVRDC – The World Vegetable Center is devoted to the conservation, maintenance and distribution of vegetable germplasm. The Center's genebank holds close to 60 000 accessions of vegetable germplasm comprising 170 genera and 435 species from 156 countries of origin, including some of the world's largest vegetable collections held by a single institution, such as for *Capsicum*, tomato, and eggplant (Ebert, 2012). The germplasm accessions and materials derived from AVRDC's breeding programs are made available to the world community as international public goods under a Material Transfer Agreement. Diversity in genetic resources conserved at AVRDC – The World Vegetable Center can either be used directly after comparative trials with the best local varieties have been conducted or they can be targeted as building blocks for breeding efforts to develop improved, superior lines of crops with desired characteristics. A relatively high number of germplasm accessions from the Center's genebank are distributed to in-house scientists, as well as scientists in national programs and the private sector, indicating on-going vibrant research and development activities with both public and private sector partners.

In recent years, AVRDC has made major efforts to collect, evaluate, and conserve locally well-adapted landraces of indigenous vegetables in South and Southeast Asia and Africa. Currently, there are about 12 000 accessions of some 200 species of indigenous vegetables conserved in the AVRDC genebank that have potential for the development of more resilient cropping systems which are well-adapted to global warming (de la Peña et al. 2011). The Center's current germplasm acquisition policy is to prioritize genetic resources at risk of erosion or extinction and to fill gaps in the existing collection as identified by AVRDC breeders. To ensure the safety of the collection, accessions of many crops such as water spinach (*Ipomoea aquatica),* hyacinth bean (*Lablab purpureus*)*,* African and Asian eggplant and its wild relatives, and African nightshade are duplicated in the Svalbard Global Seed Vault in Norway and in the National Agrobiodiversity Center of the Republic of Korea.

The Center is working with partners to collect and conserve the genetic diversity of slippery cabbage (*Abelmoschus manihot*), a popular, highly nutritious vegetable that is indigenous to China, the Indian subcontinent, Malaysia, Australia and the Pacific islands, and which is mostly propagated vegetatively in the Pacific region. Collaborating with national partners, the Center also strengthens in situ conservation of jute mallow (*Corchorus olitorius*), bottle gourd (*Lagenaria siceraria),* ridged gourd (*Luffa acutangula*) and cucumber (*Cucumis sativus*) in the Philippines through community-based conservation and multiplication to ensure availability of good quality seed for home gardens and commercial production.

All data relevant for genebank operation and accession management are recorded, uploaded, and maintained in AVGRIS (AVRDC Vegetable Genetic Resources Information System. http://203.64.245.173/avgris/.) For users of the Center's germplasm, AVGRIS provides direct access to information pertaining to the passport, characterization, and evaluation data of the accessions maintained by the Center.

To date, the Center has distributed about 625 000 seed samples (a total of 296 000 different accessions and breeding lines) to researchers and breeders of national agricultural research and extension systems, non-governmental organizations, individuals, public and private companies, and universities in 200 countries. This immense range of diverse vegetable germplasm has contributed to the release of 466 improved vegetable varieties to farmers around the world.

Enhancing utilization of indigenous vegetables

Seed production and variety release support

When selected varieties of indigenous vegetables meet the needs of both producers and consumers, demand for the crops can increase dramatically. Sufficient quantities of quality seeds of the improved varieties must be available and accessible to allow farmers to capitalize on new market opportunities. As seed of indigenous vegetables is not easily found in seed shops as only few seed companies venture into this niche market, national research and extension services need to step in – at least initially - to facilitate seed production and distribution systems at the national, local or community level if research and promotion of indigenous vegetables is to be effectively linked with the farming communities. The process of seed distribution to seed shops and farmers depends very much on national regulations. In many countries seed distribution to farmers must be preceded by a formal variety release process. Therefore, projects which intend to promote the utilization of indigenous vegetables should include multi-locational variety trials to support and enhance the variety release process. AVRDC is presently conducting such multi-locational trials with indigenous vegetables in several Asian and African countries.

From 2009 to 2011, AVRDC – The World Vegetable Center undertook project activities supported by the Council of Agriculture (COA) of Taiwan, in collaboration with national partners in Indonesia, the Philippines, and Taiwan, to promote the conservation and use of indigenous vegetables in Asia. Project activities focused on the rescue, improved conservation, and seed increase of promising lines, multi-locational variety trials and capacity building in germplasm management.

Previous project activities implemented by the Center from 2003 to 2006 in Indonesia and other countries in Southeast Asia led to the selection of eleven promising crops *viz.* 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 (*Luffa acutangula*), bottle gourd (*Lagenaria siceraria*), wax gourd (*Benincasa hispida*), and snake gourd (*Trichosanthes* spp.) (Ebert, 2011b).

In Indonesia, all crop seeds cultivated and commercialized must undergo a formal variety release process for assurance of high seed quality (Anonymous, 1992). For this reason, multi-locational tests were conducted in 2010 and 2011 in three highland ecosystems of West Java. Based on preliminary evaluations of the above 11 crops, promising lines of vegetable soybean, amaranth, roselle, and Malabar spinach were chosen for the variety release process and subsequent distribution to resource-poor farmers to improve their income and combat malnutrition (Ebert et al. 2012). Evaluations are still on-going and the prospects are that some indigenous vegetable lines of vegetable soybean and amaranth and Malabar spinach can be officially released in the near future.

Community-based seed systems

A community-based seed system for promising indigenous vegetables was initiated in 2009 in the Bicol region at Hanawan, Ocampo, Camarines Sur to enhance the role of indigenous vegetables for improved nutrition and diversified farm income in the Philippines. The project focused on seed conservation and multiplication to ensure the availability of good quality seeds for home gardens and commercial production. Integrated pest management practices were used for the control of disease and insect pests while fruits were harvested at full maturity to assure good seed quality. Several lines of five indigenous vegetables, e.g. jute mallow, cucumber, bottle gourd, eggplant, and ridged gourd have undergone seed increase. Seed samples of these lines were distributed to other agricultural research centers, farmers' organizations, non-governmental organizations and individual farmers. This community-based seed production approach has been well received by the farming community in Hanawan. The continuation and expansion of this concept to the entire Bicol region has been proposed under the Regional High Value Commercial Crops (HVCC) Program of the Department of Agriculture, and additional resources will be secured to ensure that more farmers will benefit from the project. This classification signifies that indigenous vegetables have already been elevated to high value crops in the Philippines (Ebert et al. 2012).

Improved production practices

Knowledge on improved production practices is essential to enhance utilization of indigenous vegetables as many were, or still are, simply harvested from naturally growing wild plants. Therefore, it is crucial to study and understand the agronomic requirements of indigenous vegetables including soil fertility needs, water requirements, and optimum seasonal growing periods. An awareness of biotic constraints is needed to avoid build-up of insect pests or pathogens and to ensure compatibility with other crops in the production system. Adequate pre- and postharvest handling techniques are required to ensure that quality products will reach markets and the end-user. Such techniques will facilitate harvesting, minimize contamination with microorganisms, and help the farmer deliver quality products to the market.

Value-addition is a further key consideration to increase the market share of indigenous vegetables. Some crops with a short shelf life can be processed to add value. Processing may include drying, salting, fermenting, pickling, canning and juice production, such as roselle juice. In addition to expanding the range of products of these vegetables and to avoid market saturation during peak harvest seasons by ensuring long shelf life of the value-added products, processing also can increase farmers' income. In many cases processed products fetch a higher market value than the fresh produce. In Vietnam for example, the price of pickled Chinese mustard (*Brassica juncea*) was almost twice the price of fresh, unprocessed Chinese mustard (Than et al. 2002).

Promoting indigenous vegetables

Although indigenous vegetables are consumed all over Asia and form an integral socio-cultural component of many communities, their further promotion is needed to better inform and educate a wider range of the population on their benefits. Such promotional activities may be done through demonstrations and field days and by working with schools and community health groups.

Schools are an excellent place where government programs on good health practices can be taught and implemented to achieve behavioral changes at home (Bundy et al. 2006). School gardens are a particularly effective way to advocate the production and consumption of indigenous vegetables (Holmer and Keatinge, 2012). Drescher (2002) shows that school garden programs can have multiplier effects by encouraging the establishment of vegetable gardens at the homes of pupils. The "*Gulayan sa Paaralan*" (Vegetable Gardens in Schools) program of the Philippine Department of Agriculture endorses the establishment of vegetable gardens in all 42,076 public primary and secondary schools of the country to be complemented by home and community gardens. (Department of Agriculture, 2011). The Philippine school garden program is complemented a nationwide campaign called '*Oh My Gulay*' (OMG, 2012) where actors and show business personalities advocate higher vegetable consumption in the country, including indigenous vegetables.

Indigenous vegetables also are included in AVRDC's healthy home gardening kits distributed in India and Africa. A model 6 x 6 m^2 home garden plot has been developed for two districts in India with different sets of cropping sequences; the plot can provide an adequate amount of vegetables for a family of four year-round. The home garden model is presently being modified and adapted to other regions (Keatinge et al. 2012, Hughes and Keatinge, 2012). Because they are easy to grow, yield quickly and can tolerate difficult environments, indigenous vegetables have been selected for inclusion in the Center's vegetable seed kits for immediate rehabilitation of vegetable production among households affected by natural disasters. To date the seed kits have been distributed to earthquake, typhoon and tsunami survivors in Haiti, Indonesia, Sri Lanka, Taiwan, Thailand and India (Keatinge et al. 2011).

Better food preparation methods

Food preparation is a critical aspect of ensuring beneficial phytochemicals of micronutrient-rich vegetables can be absorbed by the body. Vegetables usually are cooked for consumption. Cooking changes the concentration and bioavailability of health-promoting compounds in vegetables. Positive and negative effects have been reported as influenced by the type of processing, the type of vegetable used, and its nutritional characteristics. Cooking also changes the physical properties of vegetables, such as texture and color, factors that strongly impact consumer decisions in purchasing certain produce. Miglio et al. (2008) evaluated the effect of three cooking practices (boiling, steaming, and frying) on phytochemical contents and total antioxidant capacities of carrots, zucchini, and broccoli. They found that antioxidant activity was increased in all cooked vegetables compared with raw vegetables, most likely due to softening of the tissues and increased extractability of compounds from which antioxidant compounds are derived. The texture of steamed vegetables was better than boiled vegetables, but boiling caused discoloration. Frying had the lowest impact on softening, but was less efficient in retaining antioxidant compounds. Cooking in water preserved the antioxidant compounds, particularly carotenoids, better than the other two methods in all vegetables tested. These results may vary from one vegetable type to another but demonstrate that more research on food preparation methods is needed, especially for the under-researched indigenous vegetables.

Apart from the retention of phytochemicals and the potential increase in their bioavailability, the way novel products are presented has a major impact on the adoption, production, and consumption of indigenous vegetables. When promoting a new vegetable to farmers and consumers, food preparation methods must be available at the same time, with recipes adapted to local tastes and ingredients; the dishes also must be presented in an attractive way and should be affordable. AVRDC has developed numerous recipes with local partners to meet local tastes and cooking styles while ensuring bioavailability of micronutrients. The Center has published a collection of high-iron, good-tasting mungbean recipes from South Asia combining whole or split dehulled mungbeans with a range of different vegetables, including indigenous vegetables, to enhance bioavailability of iron. More recently, a collection of attractive and nutritious recipes of indigenous vegetables has been compiled (Lin et al. 2009).

Conclusion

Indigenous vegetables have been used for centuries by local communities since they are well adapted to their specific environments and are often part of the socio-cultural fabric. However, many are underutilized because their value is not appreciated, particularly in regions where the plants are not native. Indigenous vegetables have the potential to be introduced elsewhere for greater crop diversification and increased productivity, which would balance year-round nutrition, provide new market opportunities and enhance farm income. Moreover, they could address issues associated with climate change such as enhancing resilience of farming communities and reducing the demand on non-renewable energy sources, thus lessen the ecological footprint of the food supply chain.

A large number of indigenous vegetables have been evaluated by AVRDC. Many show promise of wider environmental suitability, low input requirements, adaptability to specific cropping systems, easy harvesting and postharvest processing, and high nutritional and health values and warrant further development for extended areas of production and consumption. However, the current imbalance in agricultural investment must be redressed to unleash the potential indigenous vegetables hold to alleviate poverty and malnutrition in the developing world.

Literature cited

Anonymous. 1992. Undang Undang No. 12 Tahun 1992 Tentang: Sistem Budidaya Tanaman. Available at: http://hukum.unsrat.ac.id/uu/uu_12_1992.pdf; accessed on: 18 April 2012.

AVRDC – The World Vegetable Center. 2008a. Point of impact: When putting all your eggs in one basket pays. AVRDC – The World Vegetable Center. Tainan.

AVRDC – The World Vegetable Center. 2008b. Point of impact: Healthy urban fast food – a new Maasai enterprise. AVRDC – The World Vegetable Center. Tainan.

Bundy D, Shaeffer S, Jukes M, Beegle K, Gillespie A, Drake L, Lee SF, Hoffman AM, Jones J, Mitchell A, Barcelona D, Camara B, Golmar C, Savioli L, Sembene M, Takeuchi T, Wright C. 2006. School-Based Health and Nutrition Programs. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, Jha P, Mills A, Musgrove P, editors. Disease Control Priorities in Developing Countries. 2nd edition. Washington (DC): World Bank; Chapter 58.

Caijing. 2011. China census shows aging population, gender imbalance, growing city dweller. www.english.caijing.com.cn

Department of Agriculture. (2011). Administrative Order Series 2011 No. 15. Republic of the Philippines, Quezon City, Philippines. http://www.da.gov.ph/n_agrilaws/AO2011/ao15.pdf.

Drescher A, 2002. Improving child nutrition and agricultural education through the promotion of school garden programs. Paper prepared for the Food and Agriculture Organization of the United Nations (FAO/TCOS) http://puvep.xu.edu.ph/publications/school_gardens.pdf

Ebert A.W. 2011a Vegetable germplasm conservation and utilization at AVRDC – The World Vegetable Center. In: Pascual JA and Pérez-Alfoca (eds.) Proc. Fifth International Symposium on Seed, Transplant and Stand Establishment of Horticultural Crops. Acta Hort. 898: 89-93.

Ebert, A.W. 2011b. Promotion of indigenous vegetables in Asia: conservation and use of selected crops in Indonesia, the Philippines, and Taiwan. In: Hummer K.E. (ed.) Proc. XXVIIIth IHC – IIIrd IS on Plant Genetic Resources. Acta Hort. 918:397-403.

Ebert, A.W., 2012. Ex situ conservation of plant genetic resources of major vegetables. **In:** H.F. Chin, B. Reed and Noor, N.M. (eds.) Conservation of Tropical Plant Species. Springer Science + Business Media LLC. NY, USA Press (in preparation).

Ebert , A.W., Hidayat I.M., and de los Santos E.B. 2012. Variety Trials of Indigenous Vegetables in Indonesia and Community-based Seed Conservation and Multiplication in the Philippines. In: 2nd International Symposium on Underutilised Plant Species – Crops for the Future – Beyond Food Security. Acta Hort. (in preparation).

Engle, L.M. and Faustino, F.C. 2007. Conserving the indigenous vegetable germplasm of Southeast Asia. Acta Hort. 752:55-60.

Hill, J.S. 2010. One fifth of plants face extinction. Available at: http://planetsave.com/2010/09/29/one-fifth-of-plants-face-extinction/; accessed on: 18 April 2012.

Holmer, R.J. 2010. Community-based vegetable production systems: an answer to the food and sanitation crisis of urban poor in the Philippines? Acta Hort. 881:125-130.

Holmer, R.J., Keatinge, J.D.H., 2012. Nourishing body and mind: How vegetable school gardens can contribute to achieving the Millennium Development Goals. Paper presented at the 2012 Rotary International Convention, 9 May 2012, Bangkok, Thailand.

Hughes J.d'A., Ebert, A.W. 2012. Research and development of underutilized plant species: the role of vegetables in assuring food and nutritional security. In: 2nd International Symposium on Underutilisied Plant Species – Crops for the Future – Beyond Food Security. Acta Hort. (in preparation).

Hughes J.d'A., Keatinge, J.D.H. 2012. The nourished millennium: how vegetables put global goals in reach. In Holmer R, Linwattana G, Nath P, eds. 2012. Proceedings of the Regional Symposium on High Value Vegetables in Southeast Asia: Production, Supply and Demand (SEAVEG 2012), 24-26 January 2012, Chiang Mai, Thailand. AVRDC – The World Vegetable Center, Publication No. 12-758. AVRDC – The World Vegetable Center, Taiwan. (in preparation)

Jarvis A., Ramirez, J., Anderson, B., Leibing, C. and Aggarwal, P. 2010. Scenarios of climate change within agriculture. p. 25-31. In: M.P. Reynolds (ed.), Climate change and crop production. CABI International, London.

Javier, E.Q. 1993. Foreword. In: J.S. Siemonsma and K. Piluek (eds.), Plant resources of Southeast Asia No. 8 Vegetables. Bogor, Indonesia.

Keatinge, J.D.H., Waliyar, F., Jamnadas, R.H., Moustafa, A., Andrade, M., Dreschel, P., Hughes, J.d'A., Kadirvel, P. and Luther K. 2010. Relearning old lessons for the future of food – By bread alone no longer: Diversifying diets with fruits and vegetables. Crop Science 50:51-63.

Keatinge, J.D.H,, Yang ,R.Y, Hughes, J.d'A., Easdown, W.J., Holmer, R., 2011. The importance of vegetables in ensuring both food and nutritional security in the attainment of the Millennium Development Goals. Food Security 3:491-501.

Keatinge, J.D.H., Chadha, M.L., Hughes, J.d'A., Easdown, W.J., Holmer, R.J., Tenkouano, A., Yang ,R.Y., Mavlyanova, R., Neave, S., Afari-Sefa, V., Luther, G., Ravishankar, M., Ojiewo, C., Belarmino, M., Ebert, A.W., Wang, J.F., Lin, L.J., 2012. Vegetable gardens and their impact on the attainment of the millennium development goals. Biological Agriculture & Horticulture 28(2) 1-15.

Lin, L.J., Hsiao, Y.Y. and Kuo, C.G. 2009. Discovering indigenous treasures: Promising indigenous vegetables from around the world. AVRDC – The World Vegetable Center Publication No. 09-720. AVRDC – The World Vegetable Center, Shanhua, Taiwan. 317 p.

Miglio, C., Chiavaro, E., Visconti, A., Fogliano, V. and Pellegrini, N. 2008. Effects of different cooking methods on nutritional and physiochemical characteristics of selected vegetables. J. Agric. Food Chem. 56:139-147.

OMG, 2012. Oh my gulay! http://www.ohmygulay.prg/omg/beta (Accessed in April 2012).

Subramanian, M.A. and Yang, R.Y. 1998. High-iron mungbean recipes from South Asia. AVRDC – The World Vegetable Center Publication No. 98-480. AVRDC – The World Vegetable Center, Shanhua, Taiwan. 35 p.

Thanh, N.T., Wu, M.H. and Lai, T.V. 2002. Northern Vietnam. The vegetable sector in Indochina Countries: Farm and household perspectives on poverty alleviation. AVRDC – The World Vegetable Center, Asian Regional Center, Bangkok, Thailand. p 111-148.

Unilever 2012. Were ancient plants more nutritious? Press release, 11 April 2012. Available at: http://www.unilever.com/mediacentre/pressreleases/2012/wereancientplantsmorenutritious.aspx. Accessed: 17 April 2012.

Weinberger, K. 2007. Are indigenous vegetables underutilized crops? Some evidence from Eastern Africa and Southeast Asia. Acta Hort. (752): 29-34.

World Health Organization and Food and Agricultural Organization. 2006. Guideline on food fortification with micronutrients. L. Allen, B. de Benoist, O. Dary and R. Hurrel. WHO, Geneva.

World Health Organization/Food and Agricultural Organization. 2004. Vitamin and mineral requirements in human nutrition. 2^{nd} edition. WHO/FAO, Geneva

Yang, R.Y. and Keding, G.B. 2009. Nutritional contribution of important African indigenous vegetables. p. 105-144. In: C.M. Shackleton, M.W. Pasquini and A.W. Drescher (eds.), African indigenous vegetables in urban agriculture. Earthscan, Virginia.