# Global Horticulture

## *Now is the Time for Action*

AVRDC

The World Vegetable Center

AVRDC
The World Vegetable Center

# Global Horticulture

## *Now is the Time for Action*

### Table of Contents

## United Nations
## Millenium Development Goals

- Eradicate extreme poverty and hunger
- Achieve universal primary education
- Promote gender equality and empower women
- Reduce child mortality
- Improve maternal health
- Combat HIV/AIDS, malaria and other diseases
- Ensure environmental sustainability
- Develop a global partnership for development

*Horticulture has an important role to play in all of the United Nations Millennium Development Goals, including alleviating poverty and hunger, empowering women, improving the health of children and women, and ensuring greater sustainability of the environment.*

# A fresh approach to fighting poverty

Thirty years ago, world leaders at the United Nations World Food Conference in Rome pledged that, *"Within a decade no child would go to bed hungry, that no family would fear for its next day's bread, and that no human being's future capabilities will be stunted by malnutrition."*

Since that time, considerable progress has been made to improve food security in many regions of the developing world. Nevertheless, 1.2 billion persons continue to live in extreme poverty and even more persons suffer from malnutrition.

The United Nations (UN) has recently declared a new series of goals for the millennium. Similar to the goals of 1974, the UN again calls for reductions in poverty and hunger. But this time, the UN has taken a more holistic view, calling for improving access to education, protecting childhood and maternal health, and sustaining the environment.[1]

Horticulture has an important role to play in all of the United Nations Millennium Development Goals (see table at left). A strengthened horticulture sector can:

- **Alleviate poverty** by creating new jobs and generating new sources of income for farmers and landless laborers.
- **Improve health** by providing the nutrients that are essential, yet lacking in the diets of billions of poor persons.
- **Enhance learning and working capacities of children and adults** through improved diets and health.
- **Improve sustainability of food production systems** through crop diversification.

Now is the time for action. Today's advances in biological sciences and communication technologies provide us with unprecedented opportunities to collaborate as a scientific community on a global scale.

AVRDC is the leading international institute for vegetable R&D. At this moment we are mobilizing a global network of experts to develop horticulture technologies that will improve economic opportunities and food security for the poor.

We invite you to read about this initiative and work with us in this endeavor.

*A strong horticulture sector will create jobs and revitalize rural economies.*

*Horticulture R&D creates jobs*

# An engine for economic growth

The needs in the developing world for horticulture R&D are greater than ever. Nearly three billion people are living on less than 2 USD or less per day. Unemployment and poverty are rampant throughout much of the world and conditions are worsening in Sub-Saharan Africa.[2]

Horticulture crops, as high value crops, have an important role to play in revitalizing rural economies. **Horticulture crop production provides jobs**—more than twice the number of jobs compared to cereal crop production, per hectare of production.[3] The shifting of cereal production toward high value horticulture crops is already increasing employment opportunities in developing countries.[4]

**Women have the most to benefit** from the rising importance of horticulture. Women, in general, play a much more significant role in horticulture crop production as compared to cereal production.[5-7]

Besides creating jobs on the farm, **the horticultural sector generates off-farm employment**—especially for women. This is the case for export and value-added processing industries, which are important sectors of economies in Latin America and Africa. In Mexico, for example, 80–90% of persons engaged in packing operations are women and even higher percentages of women workers are involved in fresh produce field operations.[8] Evidence from production industries in Africa reflect similar tendencies.[9]

Since horticultural production is very labor-intensive, **landless laborers also benefit** from the new employment opportunities created by horticultural crop production. These jobs usually provide more income than jobs obtained in most other sectors.[10,11]

In sum, a strong vegetable sector can become an engine for economic growth in developing countries.

*A strong horticulture sector will generate new and profitable sources of income for the poor.*

*Horticulture R&D generates higher incomes*

# New markets create new opportunities

Studies from the developing countries of Asia and Africa consistently show that **horticulture farmers earn higher net farm incomes** than farmers engaged in cereal production alone.[12-16]

In India, for example, fruit and vegetable producers generate five to eight times more profits than cereal farmers, depending on the crop.[17] In Kenya, the production of fruit, vegetable and flowers for export are providing farmers with six to twenty times more profits than maize, depending on the crop.[18,19]

The production of **horticultural crops may be especially attractive for small-scale farmers** since these crops usually have much lower economies of scale compared to cereal crops and livestock production. Horticulture crops have a comparative advantage over cereal crops when land is scarce and labor is abundant, which is often the case in developing countries.

Horticultural crops are seen to have great potential as alternatives to the illegal and unstable production of opium and other narcotics in Afghanistan and Latin America.[20]

Looking globally, **international trade has opened new markets for farmers** in developing countries. In many African countries, export horticulture has become a bright spot in an otherwise dim agricultural economy.[21] In Zambia, for example, cut flower exports have blossomed from US$0.3 to US$43.0 million over the past 15 years.[22]

Although export horticulture likely favors more capital-intensive medium and large-scale farmers, it still benefits small-scale producers with **increased employment opportunities**.

A stronger horticulture sector will increase employment opportunities and incomes of the poor. Now is the time for action.



*A strong horticulture sector will alleviate micronutrient malnutrition, thereby improving the lives of over 2 billion persons.*

*Shown: AVRDC's golden tomato and vegetable amaranth varieties are rich natural sources of beta-carotene (the precursor to vitamin A, which prevents blindness and protects the body against diseases).*

*Horticulture R&D alleviates malnutrition*

# We need quality as much as quantity

Over two billion persons, mostly women and children, suffer from micronutrient deficiencies in their diets.[23]

Vitamin A deficiency (VAD) alone weakens the immune system of 40% of children in developing countries, increasing their risk of death from infectious diseases.[24] VAD is the leading cause of preventable blindness and contributes to higher rates of anemia, respiratory diseases, diarrhea, measles and malaria.[25-27]

Deficiencies of vitamin A and other micronutrients increases the likelihood of HIV/AIDS transmission from mother to child and hastens the progression of the disease in infected persons.[28,29]

Iron deficiency affects at least 2 billion and perhaps up to 3.5 billion persons. Shortage of iron in diets causes reduced worker productivity, which results in economic losses in the billions of dollars at the global level.[30,31]

Economic losses due to micronutrient deficiencies are so substantial that economists at the Copenhagen Consensus agreed that relieving this crisis should be the second highest priority among world development initiatives, second only to relieving the HIV/AIDS crisis.[32]

Producing more food, by itself, is not the solution to this crisis. The quality of food, and specifically, the nutrient content of the food is just as important.

Staple grains such as rice and wheat cannot provide for a healthy diet by themselves. **Vegetables and fruits are essential for healthy diets.**[33]

Horticulture crops will play a vital role in solving this global micronutrient crisis.[34] **Vegetables and fruits are the most sustainable and affordable sources of micronutrients in diets.**

But not enough vegetables and fruits are available today, especially to poor families. In the least developed countries, the consumption of fruits and vegetables is declining.[35] Immediate steps must be taken to reverse this trend.

*A strong horticulture sector will improve diets, leading to improved learning and future earning capacities of children.*

*Shown: AVRDC feeding trials of children demonstrate that a simple mungbean-vegetable dish at lunch can significantly reduce anemia.*

*Horticulture R&D improves learning capacities*

# Bright minds lead to bright futures

There is a crisis going on in the classrooms of developing countries, but many people in the world don't know about it. Countless children are being harmed by this crisis, but most of us have turned our backs on this preventable problem.

The damage continues today, in the children's reduced ability to learn in the classroom, followed by their reduced productivity at the workplace. Malnutrition brought about by micronutrient deficiencies is harming billions of people and costing nations billions of dollars in economic losses.

AVRDC and its partners are going into schools throughout Asia and Sub-Saharan Africa to address this problem. Our teams have developed inexpensive and nutritious meals that significantly improve the health of children.[36]

Our economic studies of households in Pakistan revealed that **remedying micronutrient deficiencies raises wage levels** by an average of 3.5 to 5.5%[37]

To solve this crisis, families in developing countries need greater access to vegetables and fruits in their diets. **Enriching their diets will improve the learning capacity of children, increase worker productivity, and reduce likelihood of poverty in future generations.**[38] However, fruit and vegetable consumption in the least developing countries is actually declining.[39]

Micronutrient supplements are valuable for meeting acute cases of malnutrition, but many nutritionists agree that the most sustainable solution, especially in remote areas of developing countries, involves vegetable production and gardening.[40]

A stronger horticulture sector will improve the learning, not to mention the future earning capacities of the world's children. Now is the time for action.

*A strong horticulture sector will improve diets and reduce the devastating effects of infectious diseases, including HIV/AIDS.*

*Shown: AVRDC assists in establishing a demonstration garden of indigenous vegetables in an HIV/AIDS orphan village.*

*Horticulture R&D combats diseases*

# Cultivating health and hope

It is hard to comprehend the devastation that HIV/AIDS is having on families and economies in developing countries, and especially in Africa.

Remarkably, this devastation is just beginning. The number of HIV/AIDS cases per year in southern Africa will double by 2020. In 2020, there will be almost 10 million AIDS orphans in southern Africa.[41]

Scientists are now realizing that **a vegetable-rich diet can bolster the body's immune system and help it to fight against the disease.** To be clear, vegetables are not a magic bullet—vegetables cannot cure people who are dying from HIV/AIDS—but vegetables can help infected people to enjoy longer, more productive lives.[42]

Furthermore, studies show that **well-nourished mothers are less likely to transmit HIV to their children.**[43]This is of great importance since 55% HIV/AIDS cases in Africa are children.[44]

Mounting evidence also indicates that early HIV/AIDS infection is linked with dietary deficiencies of vitamin A and zinc, nutrients that can be obtained from vegetables.[45]

The empowerment of women, the primary producers of horticulture crops in Africa, may also reduce the spread of HIV/AIDS. Women are biologically and socio-economically more at risk of HIV infection than men. Women generally cannot require protection such as condoms, and may feel obliged to trade sex for food or money due to lack of economic opportunities.[46] **Economic opportunities generated by horticulture can empower women, making them less vulnerable to involuntary HIV/AIDS infection.**

AVRDC is actively promoting gardening programs for families and orphans suffering from the HIV/AIDS crisis, but much more work needs to be done.

*A strong horticulture sector will provide more economic opportunities and improved livelihoods for women.*

*Horticulture R&D empowers women*

# Hort helps the heart of the family

An African proverb states, "The man may be the head of the home, but the wife is the *heart*." Indeed, the more one examines life in developing countries, the more one appreciates the importance of women.

Women farmers in Sub-Saharan Africa, for example, account for 70–80% of household food production,[47] yet they have limited access to land and almost no access to credit or extension resources.[48]

Besides farming, women are the primary family member responsible for the health and education of their families. Compared to men, women spend a higher proportion of their income on food and health care for children;[49] therefore, increasing the economic status of women directly translates to improving the welfare of entire families.

**Women have the most to benefit** from the rising importance of horticulture in rural economies. Women, in general, play a much more significant role in horticultural crop production compared to cereal crop production. For example in Bangladesh, women account for 48% of all labor in vegetable production compared to only 11–20% for cereals.[50]

Besides creating jobs on the farm, **horticulture generates off-farm employment—especially for women.** For example, women comprise 91% of horticultural employees in Zimbabwe.[51]

As stated previously in this booklet, increasing vegetable and fruit production will especially **improve women's diets, health and productivity**.

AVRDC and its partners are committed toward empowering women through training programs and by promoting strong rural economies. But much more effort is needed. Now is the time for action.


*A strong horticulture sector can enrich both the fertility of the land and the livelihoods of its people.*

*Shown: AVRDC's disease-resistant mungbeans are being sown on over 3 million ha in Asia this year.*

*Horticulture R&D sustains the environment*

# Enriching the land and its people

There is a revolution sweeping across millions of farms in Asia—a mungbean revolution.

This revolution began when farmers started to realize their major cropping system, rice followed by wheat, is not environmentally sustainable. Continuous cultivation of cereals is resulting in deteriorating soils, declining water tables, salinization, and increasing insect pest and disease populations.[52]

There is hope. **Vegetable legumes can sustain the soils and enrich the diets of the poor.** After the harvest of wheat and before the planting of rice, the land remains fallow for 70 days. Among legumes, early maturing (60-day) mungbean varieties fit nicely into this window.

A team of scientists from six nations and AVRDC expanded the use of mungbeans into the region's cropping systems. The team has developed superior varieties, established a seed production network, developed improved production practices, and incorporated mungbeans into the diets of millions of families.

Farmers are enthusiastically accepting the new varieties. Literally millions of farmers will sow these varieties in 2004 and 2005. This success follows a similar pattern of success in Myanmar, where AVRDC varieties are planted on 900,000 ha today. Success was likewise achieved in China, where AVRDC-enhanced varieties are planted on 800,000 ha.[53]

Economic studies in the Indo-Gangetic Plains of India show that adding mungbeans into the rice-wheat rotation is **increasing farmers' net incomes** by 27%. The soil-enriching effects will also lead to higher yields in the rice crops that follow the mungbean planting.[54]

AVRDC's nutritional studies show that the **legumes are improving the diets of women and children, leading to greater productivity at work and school, respectively.**[55] This is further evidence that horticulture crops can enrich both the environment and its people.

*A strong horticulture sector can protect biodiversity while improving the diets and livelihoods of poor families.*

*Shown from left and clockwise: sweet potato vine, hyacinth bean, spiny bitter cucumber, nightshade, and garland chrysanthemum.*

*Horticulture R&D preserves biodiversity*

# Protecting nature's treasures

They are easy to grow, full of healthy nutrients, and can diversify income. Nearly forgotten, traditional indigenous fruits and vegetables are emerging as important crops for the future.

Many of these underutilized crops are hardy, resistant to pests and diseases, and quite acceptable to local tastes. AVRDC is focused on improving the production of these crops with the aim of improving nutrition and giving women farmers new opportunities to increase their incomes.

The tragic effects of the HIV/AIDS crisis have given indigenous vegetables and fruits a special role in Africaís future. **A diet rich in micronutrients can bolster the body's immune system and slow the progression of AIDS.**[56] Many indigenous plants are rich in micronutrients—they can even increase the bioavailability of micronutrients in staple foods when consumed together.[57]

Another important consideration is that **many indigenous plants require little or no labor to produce**; some are simply gathered. This is especially important now as the loss of life due to HIV/AIDS is drastically reducing the availability of labor for agricultural production.[58]

AVRDC has joined with its national partners to collect over 5000 indigenous vegetable types from Africa and Asia. Promising lines of these crops are being identified and selected lines are already being purified for distribution. Nutritional tests are being conducted to understand the special properties of these lines. Crop production practices are being developed and bulletins are being published in local languages.

Women farmers have the most to benefit, as these crops are mostly grown or gathered by them.[59] There is a high potential for **women to earn additional income** from selling surplus indigenous vegetables locally. Once more information on the special qualities of these crops are known, especially their anti-oxidant properties, their export market value could rise significantly.

*A strong horticulture sector can reduce pesticide abuse and provide a safe supply of food for all.*

*Shown: AVRDC nethouse and sex pheromone technologies safely protect crops while reducing the need for toxic pesticides.*

*Horticulture R&D ensures food safety*

# Safe food for all

Vegetables and fruits are not nutritious when they are tainted with pesticides. Many of today's growers are inappropriately using toxic pesticides, thereby threatening the health of themselves and consumers.

In our projects, we have seen growers spray their leafy vegetable crops the day of harvest, and sometimes even on the piles of harvested produce before it goes to market. A recent study in Bangladesh revealed that many eggplant growers spray their crops over 80 times per growing season using mixtures of non-registered pesticides.[60] This places farmers at great risk, not to mention consumers and the environment.

Access to safe vegetables must be provided to all people.

AVRDC is working with its partners to develop technologies that are **safe for farmers, consumers, and the environment.** Innovative technologies, such as insect barriers and pheromone traps are significantly reducing—and sometimes eliminating—the need to spray insecticides on leafy vegetables, eggplant and other horticulture crops. Our disease-resistant varieties are another natural means that millions of farmers use to reduce the need for applying pesticides.

Nearly all of AVRDC's technologies are **compatible with organic agriculture.** With this strong foundation to build upon, AVRDC has launched a new program on organic production technologies. This program will focus on helping millions of subsistence farmers who do not purchase chemical inputs and could increase their crop yields if they were provided with information and training in science-based organic production techniques. An international survey recently concluded there is a lack of research in organic agriculture systems.[61]

In its organic program, AVRDC will focus on components that solve problems specific to organic farming systems, such as sustainable soil management, disease-resistant cultivars, and biological pest control methods.

A stronger horticulture sector can provide for a safer and more accessible supply of food for everyone. Now is the time for action.

*Global Horticulture R&D Theme 1*

# Information management and dissemination

*Goal: Satisfy the knowledge-intensive needs of successful horticultural systems*

*R&D objectives:*

- Organize and manage an information hub for horticulture crop production, marketing chains, prices, emerging markets, certifications and phytosanitary regulations
- Increase knowledge and accessibility of genetic resources in horticultural crops
- Develop and disseminate electronic publications
- Improve human capacity through distance training

*Sampling of R&D activities:*

- Establish a database of information on genetic resources, botany, agro-ecology, crop and seed production, nutritional composition, functional properties, nutraceutical properties, IPM, post-harvest handling, and uses of fruits and vegetables
- Establish an on-line seed catalog of widely adapted germplasm for priority crops
- Establish a network of researchers to support multi-location testing of lines of vegetables, fruits, herbs and flowers
- Implement distance education programs through the Virtual World Horticulture Center

*Global Horticulture R&D Theme 2*

# Germplasm conservation and evaluation

*Goal: Establish a shared foundation of germplasm for sustainable variety development*

*R&D objectives:*

- Assemble, conserve and evaluate genetic resources of priority horticultural crops
- In situ and on-farm conservation of tree and vegetatively propagated crops
- In situ promotion of horticulture crops with potential high value or high added value

*Sampling of R&D activities:*

- Complete core collections of Capsicum and other selected priority crops for a wide range of genetic variation, including wild relatives
- Develop molecular techniques to increase efficiency of screening procedures
- Characterize the functional properties of promising medicinal herbs and select superior accessions
- Identify and conserve promising tree fruits for home garden and small-scale commercial production
- Strengthen national capacity, community participation, and regional collaboration for the conservation of indigenous vegetable, fruit, herb, and flower accessions

*Global Horticulture R&D Theme 3*

# Genetic improvement

*Goal: Create varieties that meet environmental and market requirements*

*R&D objectives:*

- Develop improved lines for enhanced productivity, nutrition, product quality and safety
- Determine gene products, metabolic processes, regulation and phenotypic expression through applications of biotechnology
- Incorporate new genes from distant relatives through tools of modern biotechnology
- Foster the development of small and medium-scale private seed companies through the development and dissemination of improved lines and through training

*Sampling of R&D activities:*

- Develop molecular markers for key tomato traits, including resistance to bacterial wilt, TYLCV, heat and drought
- Develop improved cucurbit lines with resistance to multiple viruses and improved fruit qualities
- Identify molecular markers for the development of bean lines resistant to mungbean yellow mosaic virus, angular leaf spot, common bacterial blight, anthracnose, root rot, thrips, and pod weevils
- Develop efficient gene variety enhancement protocols to improve post-harvest quality of papaya and mango

*Global Horticulture R&D Theme 4*

# Sustainable production technologies

*Goal: Develop cropping systems that protect the environment and satisfy market demands*

*R&D objectives:*

- Develop and adapt technologies for improved water use efficiency
- Reduce pesticide abuse and environmental degradation in crop production
- Develop production systems that reduce seasonality of production and market supplies
- Encourage public/private sector cooperation to increase availability of improved varieties and other technologies to farmers

*Sampling of R&D activities:*

- Adapt low-cost micro-irrigation technologies for horticulture crop and garden production in marginal areas
- Develop biopesticide, pheromone and other bio-intensive IPM technologies for fruit and vegetable crop production
- Integrate beans into the cereal-based cropping systems of Western and Sub-Saharan Africa
- Develop IPM practices for ornamental cut flowers that promote worker safety and reduce pesticide abuse
- Develop production technologies to support commercial production of promising medicinal herbs

*Global Horticulture R&D Theme 5*

# Post-harvest storage, processing and marketing

*Goal: Link small-scale farmers to profitable food chains*

*R&D objectives:*

- Improve the movement of crops from farms to markets through better handling, cold chain management, and packaging
- Support the implementation of international sanitary and phytosanitary (SPS) systems and trade regulations
- Link small-scale farms to high-value urban and export markets, processors and supermarkets

*Sampling of R&D activities:*

- Develop low-cost processing, packaging and storage technologies
- Assist farmers in developing countries to become certified for selling their produce to European and American markets
- Improve post-harvest handling, processing and marketing of indigenous crops for domestic and international markets
- Promote farmers' cooperatives for more efficient production and marketing of horticultural crops as well as improved farmer access to micro-credit, extension and technical information
- Design effective means of disseminating daily vegetable and fruit prices to producers
- Promote the grading of produce to reduce excessive handling and post-harvest losses

*Global Horticulture R&D Theme 6*

# Impact analysis and policy planning

*Goal: Fill economic and trade knowledge gaps which hinder horticultural market systems*

*R&D objectives:*

- Identify mechanisms that improve product supply systems
- Identify consumer preferences and emerging market opportunities
- Inform and facilitate communications among policymakers of rural and urban development
- Build capacities of institutions to respond to opportunities presenting a comparative advantage

*Sampling of R&D activities:*

- Engage supermarket corporations in creation of horticulture food and flower marketing opportunities for farmers from the South
- Quantify the market opportunities for horticulture crops and related industries in rural development
- Evaluate the comparative advantage of horticulture crops in targeted regions so as to promote regional trade
- Assess the impact of horticultural crop income on gender relations in rural communities
- Assess the impact of enhanced accessibility to vegetables and fruits on child survival and nutrition

# Organizational statement

## Our Mission

Reduce malnutrition and poverty through vegetable research and development

## Our Strategy

Build partnerships and mobilize resources from private and public sectors to effectively tackle problems of vegetable production and consumption. This strategy will contribute to:

- Increased productivity of the vegetable sector
- Equity in economic development in favor of rural and urban poor
- Healthy and more diversified diets for low-income families
- Environmentally friendly and safe production of vegetables
- Improved sustainability of cropping systems

## Our Core Expertise

- Management of diverse vegetable germplasm
- Innovations in crop improvement, including the use of molecular tools
- Sustainable production of safe and nutritious vegetables
- Networks of strategic alliances for generating and sharing knowledge
- Analysis of direct and indirect impacts of vegetables

## Our Unique Role

AVRDC functions as a catalyst to:

- Build international and interdisciplinary coalitions that engage in vegetable and nutrition issues
- Generate and disseminate germplasm and technology that address economic and nutritional needs of the poor
- Collect, characterize, and safeguard vegetable germplasm resources for worldwide use
- Provide globally accessible, user-friendly, science-based, appropriate technology

# AVRDC at a glance

AVRDC—The World Vegetable Center is a not-for-profit international agricultural research institute run by a management team that reports to a Board of Directors whose members come from various countries.

**Founded:** 1971.

**Annual budget:** Approximately US$12 million, from major donors such as the Asian Development Bank, Australia, France, Germany, Japan, Korea, Philippines, Republic of China, Switzerland, Thailand, United Kingdom, and United States.

**Staff:** Approximately 25 internationally recruited professional staff, and 200 locally recruited researchers, technical, and administrative staff.

**Headquarters:** Shanhua, southern Taiwan.

**Outreach offices:** Regional Center for Africa, Arusha, Tanzania; West Africa Office, Bamako, Mali; Asian Regional Center, Kamphaengsaen, Thailand; Mekong Region Project, Hanoi, Vietnam; and Central Asia and the Caucasus Region Office, Tashkent, Uzbekistan.

**Principal partners:** NARES and NGOs in developing countries.

**Improved technologies:** AVRDC-improved vegetable lines and complementary production technologies are improving diets and incomes in over 80 countries.

**Training:** AVRDC conducts training in a broad range of subject areas, including crop improvement, plant protection, and biotechnology applications at its headquarters and outreach sites.

**Research and development networks:** South Asia Vegetable Research Network (SAVERNET); Cambodia, Laos, Vietnam Network (CLVNET); Collaborative Network for Vegetable Research in Southern Africa (CONVERDS); and ASEAN-AVRDC Regional Network on Vegetable R&D (AARNET).

**Biodiversity preservation:** AVRDC has the world's most diverse collection of vegetable germplasm, approximately 54,500 accessions of 376 species from 151 countries.

## *Locations:*

**AVRDC Headquarters**
PO Box 42, Shanhua, Tainan, Taiwan 741, ROC
tel: +886 6 583 7801; fax:+886 6 583 0009
email: avrdcbox@avrdc.org

**Regional Center for Africa (RCA)**
Duluti, PO Box 10, Arusha, Tanzania
tel: +255 27 255 3102, -3093; fax: -3125
email: info@avrdc-rca.co.tz

**Asian Regional Center (ARC)**
PO Box 9-1010, Bangkok 10903 Thailand
tel: +66 2 942 8686, -8687; fax: +66 2 942 8688
email: arc_wvc@ksc.th.com

**Mekong Region Project**
Vien Rau Qua, Trau Quy, Hanoi, Vietnam.
tel: 84-4-831-4675, 876-8287.
e-mail: bountieng.ly@free.fr

**West Africa Office**
WARDA c/o ICRISAT, BP 320, Bamako, Mali
tel: +223 222 33 75; fax: + 223 222 86 83
email: v.levasseur@cgiar.org

**Central Asia and the Caucasus Region Office**
CAC Program Facilitation Unit (PFU)
P.O. Box 4564, Tashkent 700000, Uzbekistan
e-mail: mravza@yandex.ru

## References


[1] United Nations. 2004a. UN Millennium Development Goals. <http://www.un.org/millenniumgoals/>.

[2] International Food Policy Research Institute. 2001. Empowering women to achieve food security: vision 2020. Focus No. 6. IFPRI. Washington, D.C.

[3] Ali, M., U. Farooq and Y.Y. Shih. 2002. Vegetable research and development in the ASEAN region: a guideline for setting priorities. In: C.G. Kuo (ed). Perspectives of ASEAN Cooperation in Vegetable Research and Development. AVRDC, Shanhua, Taiwan. p. 20–64.

[4] Joshi, P.K., A. Gulati, P.S. Birthal and P.P. Rao. 2003. Agricultural Diversification in India. Washington D.C.: International Food Policy Research Institute.

[5] Rahman, S. 2000. Womenís employment in Bangladesh agriculture: composition, determinants and scope. Journal of Rural Studies 16(4): 497–507.

[6] Weinberger, K. and T. Lumpkin. 2004. Horticulture for poverty alleviation and economic development. Unpublished manuscript. Shanhua, Taiwan: AVRDC – The World Vegetable Center.

[7] Dolan C. and K. Sorby. 2003. Gender and Employment in High-value Agriculture and Rural Industries. Agriculture and Development Working Paper Series No. 7, Washington DC. World Bank and Oxfam background research reports.

[8] Dolan C. and K. Sorby. 2003. ibid.

[9] Weinberger, K. 2003. The impact of micronutrients on labor productivity: evidence from rural India. In: Proceedings of the 25th International Conference of Agricultural Economists. Durban, South Africa: 771–778.

[10] Weinberger, K. and T. Lumpkin. 2004. ibid.

[11] Abedullah, S. Sokhom and U. Farooq. 2002. Kingdom of Cambodia. In: M. Ali (ed.). The Vegetable Sector in Indochina Countries: Farm and Household Perspectives on Poverty Alleviation. Shanhua, Taiwan: Asian Vegetable Research and Development Center. p. 31–73.

[12] Siphandouang, P; M.H. Wu, and K. Sanatem. 2002. Lao PDR. In: M. Ali, The Vegetable Sector in Indochina Countries: Farm and Household Perspectives on Poverty Alleviation. Shanhua, Taiwan: Asian Vegetable Research and Development Center. p. 75–109.

[13] Hau, VTB; C.V. Chuong, and Abedullah. 2002. Southern Vietnam. In: M. Ali (ed.). The Vegetable Sector in Indochina Countries: Farm and Household Perspectives on Poverty Alleviation. Shanhua, Taiwan: Asian Vegetable Research and Development Center. p. 149–188.

[14] Thuy, N.T.T.; M.H. Wu, and T.V. Lai. 2002. Northern Vietnam. In: M. Ali (ed.), The Vegetable Sector in Indochina Countries: Farm and Household Perspectives on Poverty Alleviation. Shanhua, Taiwan: Asian Vegetable Research and Development Center. p. 111–148.

[15] Ali, M. and V.T.B. Hau. 2001. Vegetables in Bangladesh. Technical Bulletin No. 25. Shanhua, Taiwan: Asian Vegetable Research and Development Center.

[16] Francisco, S. 2004. Unpublished data compiled for the USDA-AVRDC project “Economic Analysis of Peri-Urban Vegetable Production in Manila”. Shanhua, Taiwan: AVRDC – The World Vegetable Center.

[17] Subramanian, S.R., S. Varadarajan, and M. Asokan. 2000. India. In: M. Ali (ed). Dynamics of vegetable production and consumption in Asia. Shanhua, Taiwan: Asian Vegetable Research and Development Center.

[18] Gabre-Madhin, E.Z. and S. Hagglade. 2003. Successes in African Agriculture: Results of an Expert Survey Markets and Structural Studies Division Discussion Paper No. 53. Washington D.C.: International Food Policy Research Institute.

[19] Minot, N. and M. Ngigi. 2004. Building on Successes in African Agriculture: Are Kenya’s Horticultural Exports a Replicable Success Story? IFPRI Focus 12, Brief 7 (April). Washington D.C.: International Food Policy Research Institute.

[20] United States Agency for International Development. 2004. Horticulture: Issues, Activities, Opportunities. A Review of USAID-funded Activities (in draft format). Washington D.C.: United States Department of Agriculture/Agricultural Research Service.

[21] Dolan, C.S.; J. Humphrey, and C. Harris-Pascal. 1999. Horticulture Commodity Chains: The Impact of the UK Market on the African Fresh Vegetable Industry. IDS Working Paper 96. Brighton: Institute of Development Studies.

[22] Gabre-Madhin, E.Z. and S. Hagglade. 2003. ibid.

[23] United Nations System Standing System Committee on Nutrition. 2004. 5th Report on the World Nutrition Situation. Nutrition for Improved Development Outcomes. Geneva: World Health Organization.

[24] United Nations. 2004b. Billions suffer from lack of vitamins and minerals in diets. <http://www.avrdc.org/news/04UNreport.html>

[25] Sommer, A. and K.P. West. 1996. Vitamin A Deficiency: Health, Survival and Vision. New York: Oxford University Press.

[26] Shankar, A.H., B. Genton, R.D. Semba, et al. 1999. Effect of vitamin A supplementation on morbidity due to Plasmodium falciparum in young children in Papua New Guinea: a randomised trial. Lancet (354):203–209.

[27] West, C.E.. 2000. Vitamin A and measles. Nutrition Review 58(2):46–54.

## References (continued)


[28] Fawzi, W.W., G.I. Msamanga, D. Hunter, et al. 2002. Randomized trial of vitamin supplements in relation to transmission of HIV-1 through breastfeeding and early child mortality. AIDS 16:1935–1944.

[29] Semba R.D., P.F. Miotti, J.D. Chipangwi, et al. 1994. Maternal vitamin A deficiency and mother to child transmission of HIV-1. Lancet 343:1593–1597.

[30] Weinberger, K. 2003. ibid.

[31] United Nations. 2004. ibid.

[32] Economist, The. 2004. Special report: Copenhagen Consensus—Putting the world to rights. The Economist. 5 June 2004. pp. 59–61.

[33] United States Department of Agriculture. 1996. The food guide pyramid. Center for Nutrition Policy and Promotion. Home and Garden Bulletin No. 252. Washington, D.C., USA.

[34] United Nations. 2004b. ibid.

[35] United Nations Food and Agriculture Organization. 2004. FAOSTAT data, 2004. Rome: FAO.

[36] Vijayalakshmi, P., S. Amirthaveni, R.P. Devadas, K. Weinberger, S.C.S. Tsou, and S. Shanmugasundaram. 2003. Enhanced bioavailability of iron from mungbeans and its effects on health of schoolchildren. Shanhua, Taiwan: AVRDC – The World Vegetable Center, Technical Bulletin No. 30, AVRDC Publication 03-559. 32 pp.

[37] AVRDC. 2002. AVRDC Report 2001. Methodologies for impact assessment in vegetable and mungbean research. p. 59–60.

[38] Haddad, L., H. Alderman, S. Appleton, L. Song, and Y. Yohannes. 2002. Reducing Child Undernutrition. How Far Does Income Growth Take Us? Washington, D.C.: International Food Policy Research Institute.

[39] United Nations Food and Agriculture Organization. 2004. ibid.

[40] World Health Organization. 2003. Micronutrient deficiencies: Combating vitamin A deficiency. <http://www.who.int/nut/vad.htm.>

[41] Nathan Associates. 2003. RCSA food security strategic option: synthesis and analysis of selected readings. Submitted to United States Agency for International Development.

[42] United Nations Food and Agriculture Organization (FAO). 2003. Feeding hope: nutrition plays key role in HIV/AIDS care.

[43] Semba, et al., ibid.

[44] Nathan Associates. ibid.

[45] Keane, L.G., M.K. Ntiru, and B.D. Giyose. 2001. Nutrition Briefs: Linking Multiple Sectors for Effective Planning and Programming. USAID SARA, SANA Project Report.

[46] Gillespie, S. Haddad, L., and R. Jackson. 2001. HIV/AIDS, food and nutrition security: impacts and actions. In: Nutrition and HIV/AIDS, Nutrition Policy Paper #20, UNAIDS, ACC/SCN.

[47] United Nations Population Fund. 2003. Women as food producers. <http://www.unfpa.org/intercenter/food/womenas.htm>

[48] Saito, K.A. 1994. Raising the productivity of women farmers in Sub-Saharan Africa. World Bank Discussion Paper #230.

[49] Haddad, L. and J. Hoddinot. 1995. Does female income share influence household expenditure pattern? Oxford Bulletin of Economics and Statistics 57(1):77-96.

[50] Rahman, S. 2000. ibid.

[51] Dolan C. and K. Sorby. 2003. ibid.

[52] Ladha, J.K. 2003. How extensive are yield declines in long-term rice-wheat experiments in Asia? In: Addressing resource conservation issues in rice-wheat systems of South Asia: a resource book. International Maize and Wheat Improvement Center, Mexico D.F.

[53] AVRDC. 2004. AVRDC Medium-Term Plan: 2004–2006. Highlights. Shanhua, Taiwan: AVRDC – The World Vegetable Center. AVRDC Publication 04-556.

[54] AVRDC. 2004. AVRDC Report 2003. Assessment of nutritional impact of mungbean research. p. 123–128.

[55] Vijayalakshmi, et. al. ibid.

[56] United Nations Food and Agriculture Organization. 2003. ibid.

[57] Vijayalakshmi, et. al. ibid.

[58] Shapouri, S. and S. Rosen. 2001. Toll on agriculture from HIV/AIDS in Sub-Saharan Africa. United States Department of Agriculture, Economic Research Service, Agriculture Information Bulletin Number 765-9.

[59] Aphane, J., M.L. Chadha, and M.O. Oluoch. 2003. Increasing the consumption of micronutrient-rich foods through production and promotion of indigenous foods. FAO-AVRDC International Workshop Proceedings, 5ñ8 March 2002, Arusha, Tanzania. AVRDC – The World Vegetable Center, Shanhua, Taiwan. AVRDC Publication No. 03-561. 77 pp.

[60] Rashid, M.A., S.N. Alam, F.M.A. Rouf, and N.S. Talekar. 2003. Socio-economic parameters of eggplant pest control in Jessore District of Bangladesh. Shanhua, Taiwan: AVRDC – The World Vegetable Center. AVRDC Publication No. 03-556. 29 pp.

[61] Stoll, G. 2003. Background study on the current state of organic agriculture research in horticulture and its perspectives in Asia. Report for BMZ/GTZ, AVRDC and IFOAM.

AVRDC – The World Vegetable Center is an international not-for-profit organization committed to ensuring the world's food security through research, development, and training.



AVRDC – The World Vegetable Center
PO Box 42, Shanhua, Tainan, Taiwan 741, ROC
Tel: +886 6 583 7801
Fax: +886 6 583 0009
Email: avrdcbox@avrdc.org
Web: www.avrdc.org

AVRDC Publication No. 04-598

Written by AVRDC staff
Lay out and design by Chen Ming-che and Thomas Kalb
Photos by Chen Ming-che and other staff from AVRDC

**Suggested citation:**
AVRDC. 2004. Global Horticulture: Now is the Time for Action. AVRDC Publication No. 04-598. Shanhua: AVRDC – The World Vegetable Center. 30 pp.

*These major donors help make possible the important work of AVRDC:*

Asian Development Bank
Australia
Republic of China
France
Germany
Japan
Republic of Korea
Philippines
Switzerland
Thailand
United Kingdom
United States of America