



AVRDC

The World Vegetable Center



# ANNUAL REPORT ..... 2012





AVRDC – The World Vegetable Center, founded in 1971, is an international nonprofit institute for vegetable research and development. The Center effectively mobilizes resources from the public and private sectors to foster the safe production of nutritious and health-promoting vegetables in developing countries. AVRDC's improved varieties and production methods help farmers increase vegetable harvests, raise incomes in poor rural and urban households, create jobs, and provide healthier, more nutritious diets for families and communities.

*Prosperity for the poor, health for all*

2012  
ANNUAL REPORT

*AVRDC - The World Vegetable Center*



**AVRDC**

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TO COUNTER THE CHALLENGES OF A CLIMATE IN FLUX, VEGETABLE GROWERS WILL NEED MORE RESILIENT CROPS AS WELL AS ADVICE AND TECHNOLOGIES SPECIFIC TO THEIR SITES AND REGIONS. AVRDC DIRECTOR GENERAL DYNO KEATINGE LISTENED AS FARMERS IN TABANAN, BALI DISCUSSED PROSPECTS FOR THE 2012 CHILI HARVEST.

# FOREWORD

## *Global climate uncertainty: What next for AVRDC?*

Climate uncertainty during the next 15 years and beyond, and the need for vegetable production to adapt, has had a substantive influence on the range of research subjects addressed in AVRDC – The World Vegetable Center’s annual portfolio for 2012. Advice from plant breeders and researchers in associated disciplines must become more crop-, site- or region-specific, and be simple enough to incorporate as meaningful targets across a diversity of breeding, vegetable production and postharvest programs. This presents a formidable challenge as the Center has scientists based in more than 15 locations worldwide and a network of partners for which it exercises a global mandate for tropical and subtropical vegetable improvement.

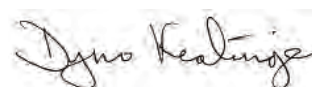
At AVRDC we believe that simple and practical guidance is needed within a relevant time horizon for the likelihood of a warming world to plan breeding or germplasm improvement programs that will be robust in the face of climate uncertainty and produce germplasm material enabling farmers to plant crops with greater resilience to cope with the perturbations of weather in any one season. We feel it is appropriate to look forward to the year 2025, as this is roughly the time required for a new vegetable variety, if first planned today, to be released,

commercialized, seed bulked and then widely adopted and grown by farmers.

Moreover, AVRDC breeders already have made long term investments, from the Center’s inception 40 years ago up to the present day, in seeking increased heat tolerance for crops such as tomatoes grown in the tropics. Looking forward to 2025 is thus viewed as a normal investment period for an international public sector research and development agency such as AVRDC and clearly discriminates it from much of the private sector, whose investment horizons need to be much more in the short to medium term.

In crops, photoperiod-temperature responses are usually highly heritable and thus air temperature can safely be assumed to be a vital measure in establishing breeding and agronomic program targets. However, issues negatively associated with increasing temperature such as a relatively greater proportion of maleness in flowers, fungal infections, and greater insect pressure exposing crops to viruses are also likely challenges that will have to be addressed. A further option in the face of increasing temperatures, always available to the vegetable production community, is to switch from a crop with less heat tolerance to one that is already adapted to higher temperatures. The AVRDC genebank collection thus becomes a vital resource in ensuring that warming environments can be provided with suitable vegetable seed options for the foreseeable future.

AVRDC believes that modern agricultural science can successfully address the problems raised by climate uncertainty, yet the lack of sufficient, immediate investment in research in horticultural disciplines worldwide places the world at severe risk of failing to attain effective food and nutritional security not only today, but also by 2050. AVRDC continues to call upon its current and potential supporters to help us redress this dangerous situation. ♦



*J.D.H. Keatinge*  
**Director General**

# ESSAY

## What response is needed from vegetable research worldwide to address potential variability in air temperature?

AVRDC – The World Vegetable Center has a global mandate for the improvement of vegetable systems to combat malnutrition and poverty in the developing world. Climate uncertainty over the next 15 years will have a substantive influence on research subjects along the entire vegetable value chain. The Intergovernmental Panel on Climate Change (IPCC) report on temperature change (Folland et al. 2001) is highly complex; in summary it suggests a generic global warming of around 0.6 °C/100 years since the late 19th century, and looks forward to the 22nd century.

In contrast, this essay strives to provide simpler and more practical guidance to vegetable scientists by adopting a simple approach to predicting future air temperatures

based on measured long-term data from AVRDC and its partner research centers. Complete methods and data for multiple sites worldwide are available in Keatinge et al. (2012a).

Long runs of annual average air temperatures were collected from different locations worldwide. All the data sets that had at least 30-year runs were subjected to regression analysis using a linear model and tested for significance. The period 1975-2011 was chosen as the comparator reference time series as this is the longest run available for AVRDC's headquarters in Taiwan, and it apparently coincides with the end of a phase of cooler weather favorable to vegetables in North America documented by several authors.

It seems that substantive recent change could have occurred in the later 20th century. For example, Mohsin & Gough (2010) suggest that though a warming trend in Toronto has been detectable from the end of the 19th century, there has been an increasing linear trend in warming since about 1970. McKeown et al. (2006) affirm that there has been a warming trend in Ontario since 1980, which followed a milder, more benign period for crop growth from 1955-75 (Lobell & Asner 2003) that was more beneficial for the production of Brassicaceae and related cool-season vegetable species (Warland et al. 2006). A similar warming trend is reported for Western Cape Province (mid-1960s to 2000) in South Africa by Midgley et al. (2005). Such conclusions regarding a change in global temperatures are supported by the IPCC 2001 report (Folland et al. 2001) and the IPCC 2007 report (Parry et al. 2007), which indicate that the 1990s are likely to have been the warmest decade of the millennium and that rapid warming occurred since 1976.

The IPCC reports concerning air temperature clearly indicate that climate change is characterized by substantive variability at a local level and this is further reflected in the results presented in this study.

At the majority of experimental sites there is a predominant trend of increasing average temperatures. Nevertheless,

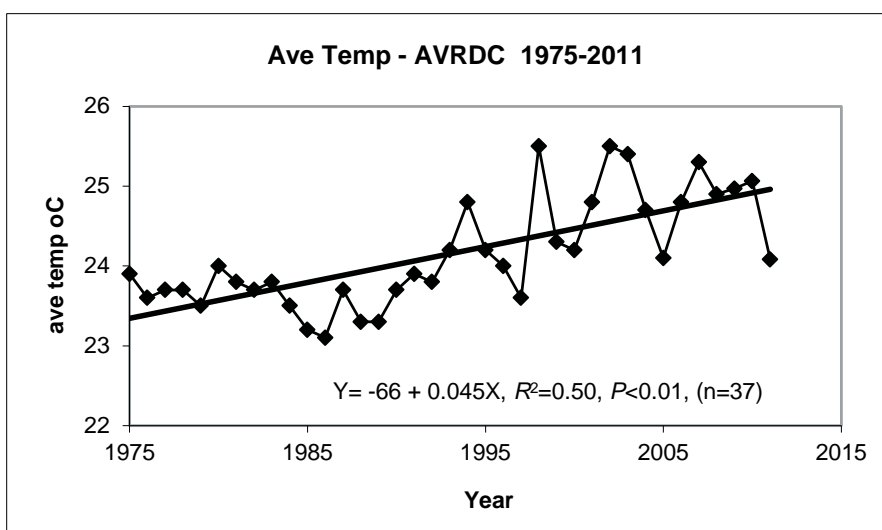


FIGURE 1. ANNUAL AVERAGE AIR TEMPERATURE AT AVRDC, 1975-2011

\*\* =  $P < 0.01$



there are also exceptions that show no significant change, for example at the Africa Rice Center (WARDA) headquarters in Benin in the last 30+ years, also at the International Institute of Tropical Agriculture IITA (Nigeria) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (India) (Keatinge et al. 2012a, b). Site specificity thus clearly remains a key challenge to vegetable scientists. For example, at AVRDC, where tomatoes and peppers are being bred for global use, the headquarters site in Taiwan is likely to experience rather faster warming than most other locations in this study, with projected average annual temperature in 2011 set to increase by 0.6 °C to 25.2 °C by 2025 (Fig. 1), which equates to a rate >4 °C per hundred years.

More effort now needs to be placed on abiotic stress tolerance research to find ways by which improved crop agronomy can help reduce environmental constraints to production. AVRDC already has made a substantive investment in research designed to introgress heat, drought and salt tolerance genes from wild species into cultivated types and in other crop management technologies to meet the growing challenges of climate uncertainty, including better targeted water use technologies, better protected agriculture and a more intelligent use of grafting.

One option in response to increasing temperatures that has always been available to the vegetable production community is to switch from a crop with less

heat tolerance to one well-adapted to existing conditions. The AVRDC genebank alone now possesses more than 430 species of vegetables with at least some of these capable of growing well irrespective of the niche agricultural environment being considered. Efforts to provide genetic adjustment in vegetables to warming and other abiotic stress have been further summarized by de la Peña et al. (2011).

Adaptation of vegetable crops to climate uncertainty is quite possible using modern agricultural science but regrettably, today's knowledge of crop-climate interactions is still very inadequate. Yet lack of sufficient, immediate investment in horticultural disciplines worldwide, especially in disciplines related to crop-environment interactions, places the world at severe risk of failing to attain effective food and nutritional security in the face of potentially substantive changes in air temperature in the coming decades. The key question then remains for AVRDC as to whether the trends elucidated in Keatinge et al. (2012a) will be maintained, for how long, and whether their geospatial variability will be altered.

At present, no one knows the answer to these questions. This essay is a call to all agricultural scientists to be more aware of the potential need for newly adapted germplasm in the near future, and to seek ways to encourage greater diversity in agricultural systems to help farmers become more resilient in the likelihood of future environmental shocks. ♦

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# STRATEGIC ORGANIZATION

## FOUR THEMES

### GERMPLASM

*Germplasm conservation, evaluation, and gene discovery*

**Goal:** Biodiversity of vegetable genetic resources is preserved and its utilization for food and nutritional security is enhanced.

**Purpose:** Vegetable germplasm collected, conserved and distributed; the collection evaluated to identify those accessions with desirable traits, and their genes identified, characterized, and introgressed using classical and molecular technologies

### BREEDING

*Genetic enhancement and varietal development of vegetables*

**Goal:** Varieties with potential to expand opportunities in tropical vegetable production.

**Purpose:** Farmers obtain varieties and lines of major vegetables that produce high yields of nutritious and marketable food with less health risk and environmental damage.

### PRODUCTION

*Safe and sustainable vegetable production systems*

**Goal:** Substantial contributions to safe and sustainable vegetable production generated.

**Purpose:** Increased supply of safer vegetables through adoption of profitable, environmentally sound practices by farmers leading to knowledge-based farming.

### CONSUMPTION

*Balanced diets through increased access to and utilization of nutritious vegetables*

**Goal:** Consumer health improved by increased consumption of nutritious vegetables for a balanced diet.

**Purpose:** Increased public awareness, accessibility and utilization of nutritious and diverse vegetables.

*The Asian Vegetable Research and Development Center, established in 1971, formally changed its name to AVRDC – The World Vegetable Center in 2008. The name change reflects the wider geographical scope of the Center's work as it expands activities to greater parts of Asia and beyond, reaching out to sub-Saharan Africa, Oceania, and Central and West Asia and North Africa.*

The Center's headquarters is located in Shanhua, Taiwan. Three regional offices are located in Bangkok, Thailand (East and Southeast Asia), Arusha, Tanzania (Regional Center for Africa), and Hyderabad, India (South Asia). Work in West Asia and North Africa, coordinated from a regional office in Dubai, United Arab Emirates, was put on hold in the second quarter of 2012. Additional offices, staff members functions and are located in Mali, Cameroon, Bangladesh, Uzbekistan, Indonesia and Fiji.

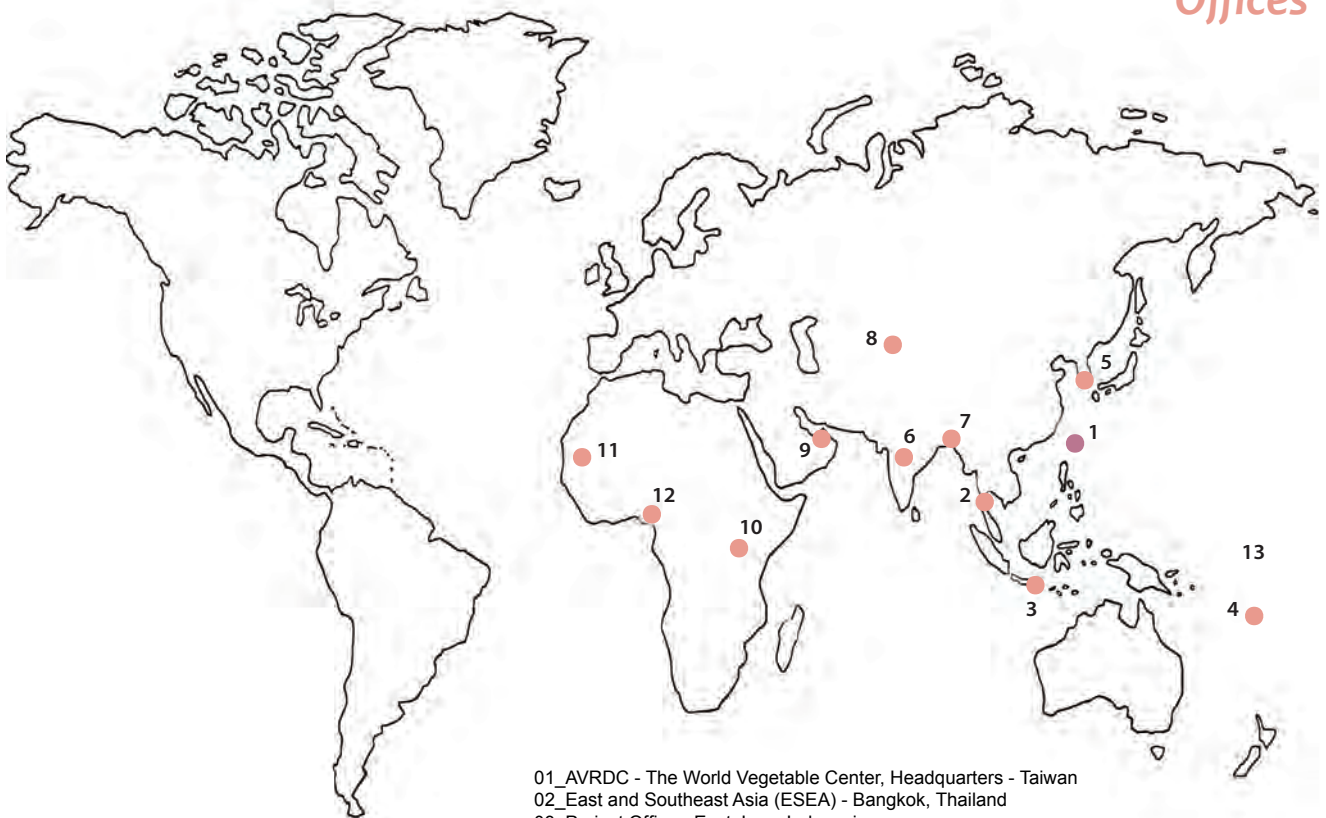
The Center's research and development activities are organized under **four separate broad themes** to encompass the vegetable value chain. The four themes are integrated in a matrix with the regional centers and headquarters. Both research and development components are built into each theme's activities. Results from adapted and applied research are used to formulate the development component of the themes to generate positive outcomes and impacts among target beneficiaries.

In 2012, the Center's activities were conducted in active partnership with the public and private sectors. Research activities involved national agricultural research systems, international organizations, private institutions and advanced education and research institutes. Emphasizing the need to ensure sustainability of development activities in targeted sites, the Center collaborated and worked within national government and nongovernmental agricultural systems, farmers' groups, women's groups and community-based organizations. All activities were conducted with a strong focus on capacity building, promotion and advocacy for improved production and enhanced consumption of vegetables. ♦





## Offices

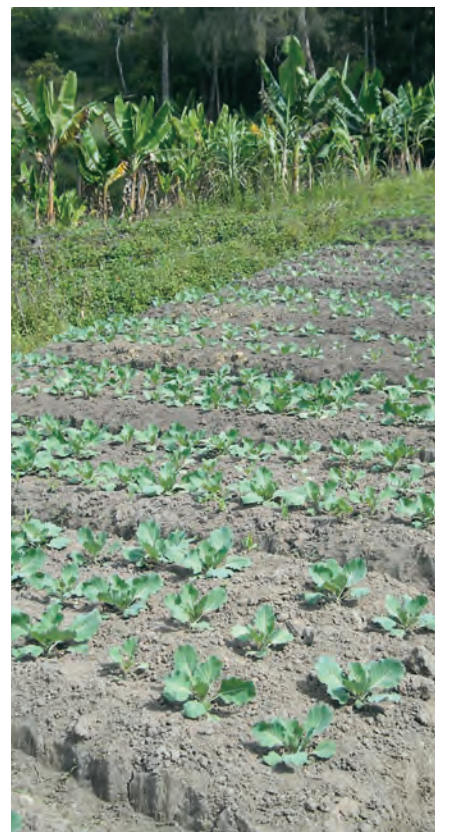


- 01\_AVRDC - The World Vegetable Center, Headquarters - Taiwan
- 02\_East and Southeast Asia (ESEA) - Bangkok, Thailand
- 03\_Project Office - East Java, Indonesia
- 04\_Project Office - Fiji
- 05\_Korean Sub-Center - Suwon, Republic of Korea
- 06\_South Asia (SA) - Hyderabad, India
- 07\_Project Office - Bangladesh
- 08\_Office for Central Asia and the Caucasus - Tashkent, Uzbekistan
- 09\_Central and West Asia and North Africa (CWANA) - Dubai, UAE
- 10\_Regional Center for Africa (RCA) - Arusha, Tanzania
- 11\_Office for West and Central Africa - Bamako, Mali
- 12\_Project Office - Yaoundé, Cameroon
- 13\_Oceania (through Headquarters, Taiwan)



## STRUCTURE

The organizational structure of AVRDC – The World Vegetable Center serves the needs of an expanding and increasingly decentralized institution. The Center’s senior management comprises a Director General, a Deputy Director General for Research, a Deputy Director General for Administration and Services, and Directors of Finance and Human Resources. Senior management provides strategic and administrative guidelines for the Center’s research and development undertakings. A further level of management consists of Global Theme Leaders and Regional Directors. Senior staff are members of two institutional committees, established to address the Center’s strategic implementation: the Institutional Management Committee (chaired by the Director General) and the Institutional Research and Development Committee (chaired by the Deputy Director General – Research). Implementation of the Center’s activities is supported internally by various support groups (e.g. biometrics, global technology dissemination, grants and partnership development, communication and information) and externally by donor communities committed to the Center’s cause. ♦



# GLOBAL ACTION

*Through its regional centers and project offices, AVRDC – The World Vegetable Center gains an intimate, up-to-date understanding of the economic, environmental, and social constraints faced by the rural and urban poor in developing countries. Close ties to communities, regional organizations, and national institutes ensure our global research has local impact and purpose.*



## Regional Center for Africa

In 2012, the Regional Center for Africa witnessed increased project funding at all locations, allowing for reasonable expansion in personnel and activities and upgrading of infrastructure, including the completion of onion storage facilities and screen houses at Samanko station in Mali and the construction of a Postharvest Training and Services Center at Arusha in Tanzania.

Fast-tracking improved varieties and providing seed in conjunction with training of trainers and communities remained the main activities of the Center in the region. Nearly 11,000 seed kits were distributed in collaboration with Helen Keller International and the Food and Agriculture Organisation (FAO) in Tanzania, partly to assist communities in their effort to recover from natural disasters.

The center participated in the United States Agency for International Development (USAID)-sponsored Africa RISING program for sustainable intensification of farming systems. Preliminary studies to characterize cereal-vegetable production systems showed that, in Ghana for example, households cultivate a variety of vegetables but only in small quantities to supply household food requirements. Of the surveyed households, 36% grew vegetables as field crops and the main vegetable crops were pepper (100% of households) followed by okra (96%), tomatoes (91%), amaranth (84%), jute mallow (73%), and cowpea leaves (62%). Except for onion, tomato and watermelon, which are cultivated during the cold-dry season, most vegetables were produced under rain-fed agriculture and integrated with major field crops like maize, millet and sorghum.

The study also revealed that leafy vegetables were produced for domestic consumption while others (tomato, pepper, watermelon and eggplant) were cultivated for cash, a fact that has motivated increased cultivation of vegetables over the past ten years. These findings have major implications for the deployment of improved vegetable varieties in the region as sole crops in the off-season, or in combination with staple crops in the rainy season.

With support from the Australian Center for International Agricultural Research (ACIAR), a preliminary study on “Improving income and nutrition in Eastern and Southern Africa by enhancing vegetable based farming and food systems” was conducted in Ethiopia, Malawi, Mozambique and Tanzania. The study suggested there was a disconnect between research and



**PRELIMINARY SURVEYS PROVIDED DATA TO GUIDE RESEARCHERS IN THE SELECTION OF CROPS SUITED FOR SPECIFIC CLIMATES AND MARKET PREFERENCES IN AFRICA.**

practice that could be addressed by an operational model in which (i) testing and deployment of varieties and associated technologies to boost the availability of vegetables would link to (ii) education on postharvest strategies and food preparation to boost market access and consumption while (iii) building the capacity of producers as part of the project exit strategy and legacy.

This model would require a shift in how the Center engages with partners to generate and disseminate research outcomes at the community level, notably by adopting a network support strategy that is compatible with the small size of the AVRDC team in the region. This would allow for the (i) pursuit of core activities on improved varieties and seed systems, good agricultural practices for increased nutrition and income, and supportive policies and (ii) fast-track dissemination of outputs through the networks.

Such a strategy would bridge research and practice by focusing interventions in Best Practice Demonstration and Training Hubs embedded within vegetable farming communities. The hubs, currently serving as sites for crop trials and experimentation, would also offer educational interventions to empower producers with productivity-enhancing technologies within effective value chains. In 2012, pilot hubs were set up in southern Mali and northern Cameroon with funding support from USAID and Projet D'appui Au Développement Des



Filières Agricoles (PADFA) and the International Fund for Agricultural Development (IFAD).

As 2012 drew to a close, the Center commemorated 20 years of presence in sub-Saharan Africa. The region's stronger capacity for vegetable research and development through network support mechanisms reflects on a successful regional strategy. An important achievement in this regard was the signing of a Memorandum of Understanding with the African Seed Trade Association, which will give impetus to the dissemination of lines developed in previous years under AVRDC's vegetable breeding and seed systems projects. ♦

## Central & West Asia and North Africa

In 2012 the Center conducted several capacity building activities in West Asia and North Africa to address the constraints of vegetable production in the hot, arid climate of the region. This included multilocation trials for improved, heat-tolerant germplasm and training courses on grafting technology to reduce the incidence of soil-borne diseases. Male and female participants of these activities included farmers, representatives of the private sector, government staff, and university staff and students. A Memorandum of Agreement was signed with the Sultanate of Oman to add to the previously signed agreement with a private partner in the State of Qatar.

Although these collaborations provided a platform to strengthen and expand the Center's undertakings in the region, unfortunately 2012 saw a considerable slowing down of activities in the latter part of the year due to the regretted resignation of the Center's Regional Director, who had a crucial role in increasing the Center's visibility and activities in the region. Collaboration with the International Center for Agricultural Research in the Dry Areas (ICARDA) has been put on hold; the Center's assets are still located within ICARDA premises in Dubai, United Arab Emirates. However, the Center continues to interact scientifically with the Abu Dhabi Food Control Authority, particularly in agronomic studies

related to vegetable production in arid areas, and under protected cultivation.

The Center’s activities in Central Asia and the Caucasus were conducted under the auspices of the region’s research and development network and concentrated on the following core activities: collaborative research with partner institutes on introduction of superior germplasm, regional variety trials, development of improved vegetable crop varieties, consumption of a more balanced diet, improved technology adoption, capacity building, and collection and establishment of baseline data on vegetables.

A total of 184 vegetable accessions from ten vegetable crop species were introduced and evaluated in variety trials under different soil and climatic conditions to assess their standard morphological characteristics, biological and marketability traits. As a result, a number of promising accessions and lines were selected: tomato and chili lines in Armenia and Tajikistan, hot pepper lines in Armenia and Georgia, two Pisum pea accessions in Armenia, Kazakhstan and Uzbekistan and one gourd accession in Kazakhstan and Uzbekistan. Seed was multiplied to conduct competitive trials.

Twenty-three varieties of eight vegetable crops were under state variety testing in Armenia, Azerbaijan, Kazakhstan, Tajikistan and Uzbekistan. Eight varieties of five crops were released and

included in state registries: tomato variety ‘Rubina’ (CLN 1558B) in Armenia; hot pepper varieties ‘Punj’ (CO1803) in Armenia and ‘Erekshe’ (0337-7069) in Kazakhstan; sweet pepper varieties ‘Mili’ (PBC271) in Armenia and ‘Kozy-Korpesh’ (0237-7011) in Kazakhstan; soybean variety ‘Inju’ (AGS437) in Kazakhstan; mungbean varieties ‘Zhasyl Dan’ (VC6492-59) in Kazakhstan and ‘Turon’ (VC6153B-20G) in Uzbekistan. Seed multiplication of the released varieties was conducted throughout the year to provide farmers with quality seeds for vegetable production and to local private sector companies for further distribution. The newly released varieties have high potential to increase the production of nutritious vegetables, diversify diets, increase farmers’ income and open exports of fresh and processed vegetables.

Research on tomato grafting in the greenhouse during the winter-spring period was finalized at Tashkent State Agrarian University, Uzbekistan. Four promising tomato lines were selected as rootstocks and recommended for use in grafting. The technique will allow farmers to increase productivity and quality of tomato production.

A pilot school garden at Bostanlyk Agricultural College and 15 home gardens were established in the Piedmont area of Uzbekistan. Seed of eight new varieties were distributed to farmers, families and students to promote vegetable production in home, school and community gardens. Nutritious





vegetable varieties were introduced into school kitchens to promote diet improvement in the area. Analyses of the chemical composition of vegetable soybean and new varieties of *Pisum* pea were conducted and recommendations were submitted to processing firms. Five improved nutritious recipes for vegetable soybean were developed, tested and presented at various workshops and training courses.

Capacity building activities were conducted through student internships, workshops and training courses, and field days. In Uzbekistan two postgraduate students continued doing research in vegetable soybean and hot pepper. One master's student has defended his thesis on tomato and one Ph.D student defended his doctoral thesis on Chinese leafy cabbage. Five different training courses were held in the area to build capacity of 82 participants (55% women) on techniques in breeding, seed multiplication, postharvest vegetable value addition and diet diversity. In addition, four workshops were organized jointly with the Ministry of Agriculture, the Ministry of Health, UzLiDep (an entrepreneur's agency), Chefs Association, representatives of the Parliament and local government, research institutes and universities to empower a total of 190 people, including 126 women (66%) in vegetable production for healthy diets.

Information and technology were disseminated through field days, demonstration plots, farmer exhibitions, newsletters, and mass

media. In 2012 more than 200 people (38% women) participated in farmer field days, including government representatives, state ministers, members of farmer associations, and representatives from the private sector and higher education institutions. ♦



**IN 2012, NINE IMPROVED VARIETIES OF FIVE VEGETABLE CROPS DEVELOPED FROM AVRDC GERmplasm WERE RELEASED BY STATE REGISTRIES IN CENTRAL ASIA AND THE CAUCASUS.**

## East and Southeast Asia

2012 marked the 30th anniversary of the Center's presence in the region. AVRDC's Thailand Outreach Program, initiated in 1982, evolved into the Asian Regional Center in 1992, and was renamed AVRDC East and Southeast Asia in 2010. Activities in the region are carried out at the Administrative Office in Bangkok, Bangkok, Thailand, the Research and Training Station in Kamphaeng Saen, Nakhon Pathom, Thailand and a project office in Malang, East Java, Indonesia.

Research fellows and interns from the University of Freiburg, Germany assisted in the implementation of the Gesellschaft für Internationale Zusammenarbeit (GIZ) funded project "Understanding Urban and Periurban Vegetable Production and Marketing Systems through GIS-based Community Food Mapping in Greater Bangkok, Thailand" in collaboration with Kasetsart University. Surveys among vegetable producers and consumers have been conducted and corresponding GIS-based maps generated.

The regional office hosts AVRDC's global crop improvement program for bitter melon (*Momordica charantia*) and pumpkin (*Cucurbita moschata*), including a component of the GIZ-funded project "A better bitter melon: Exploiting bitter melon (*Momordica charantia* L.) to increase incomes, manage type 2 diabetes, and promote health in

developing countries.” Another GIZ-supported project “Less loss, more profit, better health: Reducing the losses caused by the pod borer (*Maruca vitrata*) on vegetable legumes” is in its third and last year. A third GIZ-supported project “Beating Begomoviruses: Better livelihoods for farmers in tropical Asia with begomovirus-resistant tomato, hot pepper and mungbean and integrated disease management” had its inception workshop in Kamphaeng Saen in May 2012; the first set of field trials began in October.

The Japan International Research Center for Agricultural Sciences (JIRCAS) commissioned a third survey under the project “Fermented vegetables of Thailand,” which is being conducted in different provinces of northeast Thailand. A project planning workshop for “Vegetables Go to School” was held in collaboration with the Swiss Agency for Development and Cooperation (SDC) from 14-16 November 2012. The project will take place in Bhutan, Burkina Faso, Nepal and Tanzania, with collaboration from partner agencies from Indonesia and the Philippines.

The United States Agency for International Development (USAID)-funded research and development project “Mobilizing vegetable genetic resources to enhance household nutrition, income and livelihoods in Indonesia” is in its second year, focusing on East Java and Bali. Activities include variety trials, seed production and school gardens



**SCHOOL GARDENS IN INDONESIA BROUGHT BENEFITS TO THE CLASSROOM AND THE COMMUNITY. A PROJECT TO PROMOTE SCHOOL GARDENS IN NEPAL, BHUTAN, TANZANIA, BURKINA FASO, THE PHILIPPINES AND INDONESIA IS UNDERWAY.**

where vegetables are harvested for consumption at home.

AVRDC East and Southeast Asia has partnered with the Economic and Social Commission for Asia and the Pacific of the United Nations (UN-ESCAP), under the leadership of the Centre for Alleviation of Poverty through Sustainable Agriculture (CAPSA) and with financial support of the European Union to join forces for improved food security and nutrition of the poorest and most vulnerable people in South and Southeast Asia through the SATNET Asia project. SATNET focuses on supporting innovation by strengthening South-South dialogue and intraregional learning on sustainable agriculture

technologies and trade facilitation. AVRDC’s role is to facilitate capacity building in sustainable technologies for agricultural production and processing through residential training in Thailand and in-country training in Cambodia, Laos, Indonesia and Myanmar. The 31st International Vegetable Training Course (IVTC) was held from 10 September to 30 November 2012 at the Research and Training Station in Kamphaeng Saen. The 2012 course attracted 38 participants from 12 countries. The USAID Horticulture Collaborative Research Support Program (HortCRSP) Regional Center of Innovation at Kasetsart University became an official partner of the International Vegetable Training Course in 2012.

In partnership with Thailand's Department of Agriculture, Vegetable Science International Network (VEGINET), the Horticultural Science Society of Thailand and the Association of Southeast Asian Nations (ASEAN) through the ASEAN-AVRDC Regional Network for Vegetable Research and Development (AARNET), the regional office prepared and successfully hosted a symposium on "High Value Vegetables in Southeast Asia: Production, Supply and Demand (SEAVEG 2012)" from 24-26 January 2012 in Chiang Mai, Thailand, as part of the International Horticulture Exposition "Royal Flora Ratchaphruek 2011-2012." More than 200 participants from 25 different countries attended. Other significant AARNET activities were the Steering Committee Meeting held in Singapore on 15-16 May 2012, as well as an expert consultation on "Home, School and other Public Facility Vegetable Gardens in Southeast Asia" in Bangkok on 27-31 August 2012.

The Regional Director presented papers at the 2012 Rotary International Convention on 9 May 2012 in Bangkok, the Agriculture and Rural Development Day at Rio+20 on 18 June 2012 in Rio de Janeiro, the Expert Working Group Meeting on Food Waste in Southeast Asia on 23-24 August 2012 in Singapore, and the Southeast Asian Ministers of Education Organization's Regional Center for Educational Innovation and Technology 13th International Conference from 11-13 December 2012 in Manila. ♦

## South Asia

The main regional activities were in the Sir Ratan Tata Trust (SRTT)-funded project "Improving vegetable production and consumption for sustainable rural livelihoods in Jharkhand and Punjab, India," expanding legume breeding program activities, and the Gesellschaft für Internationale Zusammenarbeit (GIZ)-funded projects in bitter melon and begomoviruses. Disaster response seed kits were successfully distributed while a new United States Agency for International Development (USAID) project in conjunction with the International Potato Center (CIP) began in Bangladesh and new projects were developed for Pakistan, Nepal and Bhutan to begin in 2013.

The SRTT project is in its fifth and final year. Extensive demonstrations, field days and training activities at field sites in Jharkhand and Punjab reached more than 9500 farmers. Sustainable local seed supply systems were developed and on-station trials continued to refine production technology. In Jharkhand, scaling-up activities focused on improved vegetable production while in the emphasis in Punjab was on improved nutrition. Eighteen new extension publications were produced in Hindi, Punjabi and English including recommended practices for six crops in Jharkhand and three crops under net houses in Punjab. Other leaflets were printed on growing a home garden, healthy

seedling production, composting and starter solutions.

In Jharkhand our NGO partner Krishi Gram Vikas Kendra (KGVK) began production of certified seed of cowpea, garden pea and two AVRDC hybrid tomatoes. For the first time, farmers and partner NGOs purchased their own seed. KGVK also produced home garden kits and portable nets for seedling production. Following a successful presentation on project progress to the SRTT Board, approval has been given for a second phase of the project that is likely to start in 2014.

Mungbean breeding activities continued, focusing on disease resistance and identifying lines with high methionine content. Screening trials involving 50 mungbean lines were tested in three locations in India for mungbean yellow mosaic disease. Two international mungbean workshops were held in Hyderabad during the year involving participants from Asia, Canada and Australia. These provided input for planning future international projects and showcased AVRDC's work in organizing mungbean breeding data in Agrobase and the International Crop Information System (ICIS) to improve international collaborative breeding efforts.

A new USAID-funded four year project in collaboration with CIP began in southern Bangladesh. It involves introduction of improved varieties, improved production

systems, increasing incomes and nutrition and improving institutional linkages between national and international partners and the public and private sectors. The second-year trials of bitter gourd were successfully completed in Hyderabad as a part of the GIZ-funded project on improving the health benefits of bitter gourd to overcome diabetes. A new Australian Centre for International Agricultural Research (ACIAR)-funded project began in Eastern India to improve livelihoods in upland areas, and a proposal for a large new USAID-funded project in Pakistan was approved. A Swiss Development Corporation (SDC)-funded project to promote school gardens was given preliminary approval and will include work in Nepal and Bhutan.

A total of 10,000 disaster response seed packs containing seven leafy vegetables were distributed through Catholic Relief Services (CRS) to flood victims in Odisha and Assam in India. An evaluation led by CRS in Odisha showed very positive benefits of the disaster seed packs in improving vegetable supplies. A new joint three-year project funded by the COFRA Foundation has been approved to provide long-term support for flood-affected families in Odisha, including improved home gardens and seed supplies. ♦



**AMARANTH SEED IN AVRDC DISASTER RESPONSE SEED PACKS DISTRIBUTED IN ODISHA, INDIA PRODUCED MORE VIGOROUS AND TASTIER PLANTS THAN LOCAL VARIETIES, PROMPTING MRS. KOMALA DEI OF TARINGIRA VILLAGE TO PRUNE THE TIPS AND EXTEND HER HARVEST OF NUTRITIOUS LEAVES.**

## Oceania

The population in Oceania, excluding Australia, New Zealand and Hawaii, can be subdivided into Melanesia (approximately 7 million people), Micronesia (0.57 million) and Polynesia (1.66 million). Despite their diverse cultures and ethnic groups, the Pacific Island countries share common challenges, including high non-communicable disease rates, slow economic development and issues related to climate change. AVRDC – The World Vegetable Center has been mobilizing its vegetable germplasm and technology resources in the region in an effort to contribute to counteracting the challenges through improved production and increased consumption of vegetables.

AVRDC has two offices in the Pacific: one in Honiara, the Solomon Islands and the second in Fiji at Sigatoka. The Center initiated the process to ensure a strong base in the region by holding discussions with the Government of the Republic of Fiji as the first stage to developing a Memorandum of Understanding to host the Center, in addition to the current partnerships and linkages. The Center also committed resources to hire a consultant to strengthen the Center's presence in the region until the Memorandum of Understanding is formally agreed and signed.

2012 marked the first year of two AVRDC projects in the region funded by the Australian Centre for International Agricultural



Research (ACIAR). The projects are being implemented in Fiji, Samoa, Solomon Islands and Tonga, and aim to improve the livelihoods of smallholder farmers and their communities by income enhancement through vegetable production. Activities were planned with the objective of building capacity to support sustainable intensification of high-value vegetable crop production for export and domestic markets.

Capitalizing on agro-business opportunities related to tourism in the region, the Center also developed and implemented a series of pilot-level integrated participatory guarantee schemes as a model to improve vegetable supplies to hotel and resorts, a market niche. Main activities conducted in 2012 in the early phase of the projects included evaluation of 11 AVRDC-developed tomato lines in four countries; a baseline survey was conducted to

understand current production, postharvest and marketing practices among the smallholder farmers; and a soil survey was done to measure soil health status. ♦

**ARRIVING AT A SHARED UNDERSTANDING OF THE VEGETABLE VALUE CHAIN IN THE PACIFIC ISLANDS IS A CHALLENGING BUT NECESSARY EXERCISE FOR PRODUCERS HOPING TO ADDRESS BOTTLENECKS, TAP NEW MARKETS AND GENERATE MORE INCOME.**



A SIMPLE SOLAR DRYER ON DISPLAY AT THE POSTHARVEST TRAINING AND SERVICES CENTER IN ARUSHA, TANZANIA, WHICH OPENED IN 2012.

FARMERS AROUND THE WORLD PARTICIPATED IN AVRDC VEGETABLE TRIALS TO SELECT THE LINES AND VARIETIES BEST SUITED TO LOCAL CLIMATES AND MARKETS. ONIONS WERE AMONG THE VEGETABLES EVALUATED IN CAMEROON AND MALI .



# ACHIEVEMENTS on OUTPUT TARGETS 2012

## GERMPLASM: Germplasm conservation, evaluation and gene discovery

**Output 1:** Vegetable genetic resources (including wild relatives, breeding materials, genetic stocks and populations) collected, conserved and distributed

**Outcome:** Vegetable genetic resources preserved and made available globally for crop improvement

Activities	Output Targets 2012	Achievements
<b>Activity 1.1</b> Collect/acquire and conserve vegetable and legume germplasm	<ul style="list-style-type: none"> <li>200 accessions collected/acquired at the Center's headquarters</li> <li>90 accessions/breeding lines collected/acquired from hubs in sub-Saharan Africa for safety duplication in the Regional Center for Africa</li> </ul>	<ul style="list-style-type: none"> <li>A total of 570 accessions of vegetable germplasm was assembled and registered</li> <li>A total of 8 accessions was acquired by Regional Center for Africa</li> </ul>
<b>Activity 1.2</b> Maintain effective regeneration of priority vegetable germplasm	<ul style="list-style-type: none"> <li>1500 accessions regenerated at the Center's headquarters</li> <li>150 accessions regenerated at Regional Center for Africa</li> <li>Production and increase of good quality seed: 10 crops for nutritional seed kit; advanced lines for multi-location and on-farm trials; maintenance of breeder materials</li> </ul>	<ul style="list-style-type: none"> <li>1604 accessions were regenerated at the Center's headquarters</li> <li>217 accessions of 11 crops were regenerated at the Regional Center for Africa</li> <li>Seed of 26 lines of 10 crops was multiplied for different purposes</li> </ul>
<b>Activity 1.3</b> Distribute vegetable germplasm accessions and improved lines worldwide	<ul style="list-style-type: none"> <li>80% of vegetable germplasm requests served</li> <li>5,000 accessions/breeding lines distributed worldwide from headquarters</li> <li>1000 accessions/breeding lines distributed by Regional Center for Africa to public and private partners</li> </ul>	<ul style="list-style-type: none"> <li>75.4% of seed requests (269 out of 357) were successfully served</li> <li>A total of 6848 accessions (4246 genebank accessions and 2602 breeding lines) were distributed from headquarters.</li> <li>651 accessions of 18 crops were distributed from Regional Center for Africa; additional 96 accessions of 16 crops distributed to non-governmental organizations.</li> <li>16 elite soybean and 50 elite mungbean lines were distributed by for the office for South Asia</li> <li>13 AVRDC bitter melon germplasm accessions were distributed by the office for East and Southeast Asia.</li> </ul>
<b>Activity 1.4</b> Safety duplicate AVRDC - The World Vegetable Center's germplasm in other genebanks	<ul style="list-style-type: none"> <li>1500 accessions from the Center's headquarters duplicated at National Agrobiodiversity Center, Korea and Svalbard Global Seed Vault, Norway</li> <li>200 accessions from Regional Center for Africa duplicated at the Center's headquarters and Svalbard Global Seed Vault, Norway</li> </ul>	<ul style="list-style-type: none"> <li>1788 accessions from the Center's headquarters were duplicated at National Agrobiodiversity Center, Korea and 1742 accessions at the Svalbard Global Seed Vault, Norway</li> <li>141 accessions from Regional Center for Africa were duplicated at the Center's headquarters</li> </ul>

## ACHIEVEMENTS

<p><b>Activity 1.5</b></p> <p>Systematically store information on conservation and distribution of vegetable germplasm in AVRDC - The World Vegetable Center's electronic databases</p>	<ul style="list-style-type: none"> <li>100% of acquisition and distribution data generated in 2011 entered into the Center's Vegetable Genetic Resources Information System (AVGRIS) and Regional Center for Africa's database</li> <li>Characterization and evaluation data of the 2009/2010 regeneration cycle available in AVGRIS and Regional Center for Africa's database</li> </ul>	<ul style="list-style-type: none"> <li>100% of acquisition and distribution data generated in 2011 and 2012 was entered into the Center's Vegetable Genetic Resources Information System (AVGRIS) at headquarters</li> <li>Characterization data of 419 accessions regenerated during the 2009/2010 and 2010/11 regeneration cycles were uploaded to AVGRIS and can now be searched; the data of additional 2388 accessions is currently in the verification and uploading process.</li> </ul>
<p><b>Activity 1.6</b></p> <p>Develop effective seed health and quarantine program at AVRDC - The World Vegetable Center's headquarters and the regional centers</p>	<ul style="list-style-type: none"> <li>All seed shipments from AVRDC - The World Vegetable Center comply with host country regulations</li> </ul>	<ul style="list-style-type: none"> <li>All seed shipments from AVRDC - The World Vegetable Center complied with host country regulations in 2012</li> </ul>

**Output 2:** Germplasm characterized to enhance understanding and utilization of biodiversity in the vegetable germplasm collections

**Outcome:** Genetic diversity of AVRDC - The World Vegetable Center germplasm collections determined and marker-trait associations identified

Activities	Output Targets 2012	Achievements
<p><b>Activity 2.1</b></p> <p>Characterize morphological traits of vegetable germplasm maintained at AVRDC - The World Vegetable Center and its Regional Centers</p>	<ul style="list-style-type: none"> <li>1,500 accessions characterized at the Center's headquarters, based on standard morphological descriptors</li> <li>100 accessions characterized at Regional Center for Africa, based on standard morphological descriptors</li> <li>Seed of 50 <i>Cucurbita moschata</i> and <i>Momordica charantia</i> accessions each multiplied and preliminary evaluation completed</li> </ul>	<ul style="list-style-type: none"> <li>1456 accessions were characterized at the Center's headquarters based on standard morphological descriptors</li> <li>A total of 83 accessions of four vegetable crops were characterized at Regional Center for Africa</li> <li>A total of 33 <i>C. moschata</i> and 36 <i>M. charantia</i> accessions were multiplied and preliminary evaluation was completed</li> <li>78 accessions of 6 crops were characterized in Central Asia and Caucasus based on standard morphological descriptors.</li> </ul>
<p><b>Activity 2.2</b></p> <p>Conduct molecular characterization, genetic relationship and diversity analysis of germplasm collection</p>	<ul style="list-style-type: none"> <li>Diversity analysis of <i>Abelmoschus</i> collection (~400 accessions) accomplished</li> <li>100 simple sequence repeat (SSR) markers for <i>Momordica</i> assembled</li> </ul>	<ul style="list-style-type: none"> <li>265 <i>Abelmoschus</i> accessions have been genotyped and the data have been applied for genetic diversity analysis.</li> <li>More than 100 SSR markers was made available for <i>Momordica</i></li> </ul>
<p><b>Activity 2.3</b></p> <p>Develop, characterize, and validate AVRDC - The World Vegetable Center germplasm core collections</p>	<ul style="list-style-type: none"> <li><i>Abelmoschus</i> core collection initiated at the Center's headquarters</li> </ul>	<ul style="list-style-type: none"> <li>The <i>Abelmoschus</i> collection actually comprises 918 accessions of 4 species. Characterization of the collection at the morphological and molecular level is ongoing to establish a core collection comprising about 100 accessions encompassing about 70% of the diversity of the whole collection</li> </ul>
<p><b>Activity 2.4</b></p> <p>Conduct studies to identify markers and genes linked to important agronomic traits</p>	<ul style="list-style-type: none"> <li>Combined gene expression and quantitative trait loci (QTL) analysis in biparental populations of <i>Solanum lycopersicum</i> conducted to identify genes involved in heat tolerance</li> <li>Association genetics study conducted to identify salt tolerance QTLs in tomato</li> </ul>	<ul style="list-style-type: none"> <li>Output target postponed to 2014</li> <li>Salt tolerance traits and interaction between survival and yield traits was assessed in a <i>S. pimpinellifolium</i> germplasm panel. (Publication by Rao et al. 2012 in <i>Euphytica</i>)</li> </ul>



**Output 3:** Trait-based characterization and screening to enhance vegetable germplasm for effective use of important horticultural traits in the development of new vegetable cultivars

**Outcome:** Superior sources of genes for important horticultural traits identified

Activities	Output Targets 2012	Achievements
<p><b>Activity 3.1</b></p> <p>Identify and characterize sources of resistance to viral diseases</p>	<ul style="list-style-type: none"> <li>Tomato and pepper germplasm screened for resistance to <i>Pepper vein mottle virus –Taiwan isolate (Potyvirus)</i></li> <li>Methodology for screening tomato and pepper germplasm for resistance to Taiwan isolates of <i>Tomato spotted wilt virus</i> and <i>Capsicum chlorosis virus (Tospoviruses)</i> optimized</li> <li>Cucurbit germplasm and breeding lines confirmed for resistance to <i>Squash leaf curl Philippine virus – Taiwan isolate (Begomovirus)</i></li> </ul>	<ul style="list-style-type: none"> <li>Of the 33 pepper breeding lines that were mechanically inoculated with a Taiwan isolate of PVMV, four showed 100% resistance to infection, one line showed less than 20% infection, and the remaining lines were all susceptible.</li> <li>Preliminary testing of a TSWV isolate from pepper and a CaCV isolate from tomato obtained from the National Chung Hsin University (Taichung, Taiwan) indicates that these isolates are suitable for screening tomato and pepper breeding lines and germplasm accessions to identify sources of Tospovirus resistance.</li> <li>Of the 22 plants grown from seed of a selfed TOT6252 (<i>Cucurbita moschata</i>) plant, none showed symptoms of disease after exposure to whiteflies viruliferous with the Taiwan strain of SqLCPHV, though five of these plants did test positive for the virus by PCR.</li> </ul>
<p><b>Activity 3.2</b></p> <p>Identify and characterize sources of resistance to fungal and bacterial diseases</p>	<ul style="list-style-type: none"> <li>Pepper accessions screened for resistance to anthracnose and <i>Phytophthora</i> blight</li> <li>Tomato accessions screened for late blight resistance</li> <li>Cucurbit accessions screened for powdery mildew resistance</li> </ul>	<ul style="list-style-type: none"> <li>Four pepper breeding lines and one genebank accession (S2 generation) were confirmed resistant to <i>C. acutatum</i> pathotype CA2 at green and red fruit stage. Single plant selection does purify resistance sources against <i>Phytophthora</i> blight. Eight selected resistant lines were deposited into the genebank.</li> <li>The S1 generation of selected resistance sources was challenged with the Pi-411 and Pi-858 isolates; thereafter resistant plants were individually selected and selfed. The S2 generation was challenged with Pi-853, Pi-854, and Pi-858. Seeds of the five S2 generations were deposited into the genebank for further study and use.</li> <li>Leaf-disc based protocols for screening powdery mildew resistant cucurbit accessions in the lab were used for confirmation of resistance.</li> </ul>
<p><b>Activity 3.3</b></p> <p>Identify and characterize sources of resistance to insect pests</p>	<ul style="list-style-type: none"> <li>Bases of resistance to striped flea beetle in selected radish accessions characterized</li> <li>Okra accessions screened for their resistance to aphids in Cameroon and Taiwan</li> <li>Bitter melon accessions screened for resistance to melon fly</li> </ul>	<ul style="list-style-type: none"> <li>Low glucosinolate levels reduced <i>Phyllotreta striolata</i> feeding and damage on radish accession VI039717 (TOT1119).</li> <li>Out of 367 okra accessions screened, only three accessions were found to be resistant to aphids, and out of 252 accession, only one (VI041230) was moderately resistant to leafhopper (<i>Amrasca devastans</i>)</li> <li>One out of six bitter melon lines screened was found to be highly resistant to melon fly (THMC281)</li> </ul>
<p><b>Activity 3.5</b></p> <p>Evaluate vegetable germplasm for selected nutrition-related compounds</p>	<ul style="list-style-type: none"> <li>LC-MS profiles of non-targeted phytochemicals of commonly consumed vegetables determined</li> <li>Profile and content variation of anti-diabetic compounds of promising bitter melon germplasm determined</li> <li>Finalize analytical protocol and quantify alkaloid content in <i>Solanum</i> vegetables</li> </ul>	<ul style="list-style-type: none"> <li>Yield, planting conditions, and horticultural data of commonly consumed vegetables were documented. Chemometric methods for pattern recognitions of LC-MS profiles were conducted and a LC-MS fingerprint database developed.</li> <li>Around 147 triterpenoid compounds including isomers and glycosides were searched from 142 reports by National Taiwan University partner. The compound list was included in the bitter melon phytochemical database.</li> <li>Task postponed due to lack of financial resources and time constraints.</li> </ul>

## ACHIEVEMENTS

**Output 4:** Specialized genetic materials, molecular tools, and methods made available to enable the development of new varieties more rapidly

**Outcome:** Genes conferring improved horticultural traits introgressed, genetically mapped, and DNA markers developed for marker-assisted selection

Activities	Output Targets 2012	Achievements
<b>Activity 4.1</b> Develop mapping populations and identify QTLs for resistance to biotic stresses	<ul style="list-style-type: none"> <li>Tomato genes associated with resistance to late blight mapped</li> </ul>	<ul style="list-style-type: none"> <li>Genetic maps have been established for populations segregating for Ph4t; mapping of the resistance gene is ongoing.</li> </ul>
<b>Activity 4.2</b> Develop mapping populations and identify QTLs for tolerance to abiotic stresses	<ul style="list-style-type: none"> <li>Population development initiated for mapping of tomato genes associated with heat tolerance</li> </ul>	<ul style="list-style-type: none"> <li>First populations segregating for heat tolerance were developed and made available.</li> </ul>
<b>Activity 4.3</b> Conduct fine mapping of QTLs and develop markers for marker-assisted selection (MAS)	<ul style="list-style-type: none"> <li>Determine presence of Bwr12 on various resistance sources</li> <li>Develop gene-based marker of Bwr12</li> </ul>	<ul style="list-style-type: none"> <li>Postponed to 2013.</li> <li>Postponed to 2013.</li> </ul>
<b>Activity 4.4</b> Assemble and develop molecular marker sets for priority vegetable crops	<ul style="list-style-type: none"> <li>100 new polymorphic SSRs for <i>Momordica</i> and mungbean developed/assembled</li> <li>1000 markers for pepper developed/assembled</li> </ul>	<ul style="list-style-type: none"> <li>100 polymorphic SSRs for <i>Momordica</i> and mungbean are now available.</li> <li>1,000 markers for pepper were developed.</li> </ul>

**Output 5:** Genes affecting important horticultural traits isolated, validated, and functionally analyzed using genomics and molecular technologies

**Outcome:** Gene markers associated with important horticultural traits developed and pathogen-derived resistance to Tomato yellow leaf curl virus based on RNA interference explored

Activities	Output Targets 2012	Achievements
<b>Activity 5.3</b> Evaluate gene function and efficacy through genetic engineering	<ul style="list-style-type: none"> <li>Transformation of RNAi constructs covering multiple viral strains for non-strain specific resistance to <i>Tomato yellow leaf curl virus</i></li> </ul>	<ul style="list-style-type: none"> <li>The R<sub>3</sub> generations of the two constructs TY-01 and TY-08 were exposed to ToLCTWV and TYLCTHV. Two lines of the TY-08 construct showed a low incidence of ToLCTWV and TYLCTHV.</li> <li>Bi-RNAi construct for TYLCV was made and transformed to obtain R<sub>1</sub> seeds.</li> </ul>

**Output 6:** Intellectual Property Rights strategy on germplasm, transgenics and genes implemented

**Outcome:** AVRDC – The World Vegetable Center, national agricultural research and extension systems and the private sector benefit from using the Center's germplasm accessions and improved breeding lines

Activities	Output Targets 2012	Achievements
<b>Activity 6.1</b> Utilize, develop or improve Material Transfer Agreements (MTAs) for genebank germplasm, breeding lines and transgenic materials that support AVRDC's interests	<ul style="list-style-type: none"> <li>All outgoing seed shipments comply with the Center's MTAs</li> <li>Incoming seed are accompanied by MTA, germplasm acquisition agreement, or letter of donation</li> </ul>	<ul style="list-style-type: none"> <li>All outgoing seed shipments comply with Center's MTAs: MTA<sub>1</sub> for genebank accessions; MTA<sub>2</sub> for AVRDC-developed genetic material. SMTA is used for accessions received under SMTA or regenerated with support from the Global Crop Diversity Trust.</li> <li>Germplasm entering the Center's premises is now accompanied by appropriate documents and a phytosanitary certificate. A sub-sample will be deposited into the genebank at headquarters or the germplasm repository at the Regional Center for Africa to avoid multiple requests of the same material from the same source.</li> </ul>

**Output 7:** Capacity in germplasm conservation, evaluation, characterization, and gene discovery developed

**Outcome:** Skills of national agricultural research and extension systems' scientists in germplasm conservation, utilization and gene discovery enhanced

Activities	Output Targets 2012	Achievements
<p><b>Activity 7.1</b></p> <p>Train human resources in vegetable genetic resources conservation, management, and evaluation using conventional and advanced techniques</p>	<ul style="list-style-type: none"> <li>• Training on germplasm conservation and management conducted</li> <li>• Training on use of molecular tools for biodiversity analysis and germplasm evaluation conducted</li> </ul>	<ul style="list-style-type: none"> <li>• A total of 48 visiting scientists, students and other trainees from more than 12 countries were trained in germplasm management and conservation. 48% of trainees are female</li> <li>• Seven scientists and students from Vietnam, the Philippines and Taiwan were trained in the application of molecular tools and undertook research work in biotechnology.</li> </ul>

## BREEDING: Genetic enhancement and varietal development of vegetables

**Output 1:** Varieties and lines of vegetables with improved disease resistance, stress tolerance, quality and nutritional traits developed

**Outcome:** Lines adopted directly as varieties or used in public/private sector breeding programs

Activity	Output Targets 2012	Achievements
<p><b>Activity 1.1</b></p> <p>Develop heat tolerant and disease-resistant tropical tomato with desirable horticultural and quality traits</p>	<ul style="list-style-type: none"> <li>• 5-10 fresh market tomato lines with Ty-3 and multiple late blight resistance (Ph-2+Ph-3) evaluated in replicated yield trial, and seed multiplied for international distribution</li> <li>• Utility of markers associated with Bwr12 confirmed</li> </ul>	<ul style="list-style-type: none"> <li>• Nine lines were evaluated and four were distributed internationally</li> <li>• Difference between group means with or without Bwr-12 were 41% and 52%</li> </ul>
<p><b>Activity 1.2</b></p> <p>Develop and distribute disease-resistant chili and sweet pepper varieties (targeting anthracnose, <i>Phytophthora</i>, bacterial wilt, <i>Cucumber mosaic virus</i>, <i>Chili veinal mottle virus</i>, and/or begomoviruses)</p>	<ul style="list-style-type: none"> <li>• Seeds of 10-15 promising lines increased for multilocation evaluation/testing and for use in development</li> <li>• 1-4 advanced lines carrying resistance to two or more diseases developed</li> <li>• Crosses for insect resistance/tolerance (aphids, mites, and/or thrips) to study inheritance developed</li> </ul>	<ul style="list-style-type: none"> <li>• Ten new chili and 5 sweet pepper lines were multiplied for distribution in the International Chili Pepper Nursery #22 and International Sweet Pepper Nursery #11</li> <li>• Twenty multiple disease resistant hot pepper and 10 sweet pepper lines were selected for evaluation in future preliminary yield trials</li> <li>• Four crosses were created using insect resistant lines C00069 and PBC145 as parents</li> </ul>
<p><b>Activity 1.3</b></p> <p>Develop heat tolerant tropical sweet pepper</p>	<ul style="list-style-type: none"> <li>• Heat tolerance data consolidated and potential for use in marker development and selection methodologies assessed</li> <li>• Candidate hybrid combinations and promising lines evaluated and multiplied</li> </ul>	<ul style="list-style-type: none"> <li>• Significant additive, and additive-by-additive gene effects were detected through Generations Means Analysis of yield under high temperatures.</li> <li>• Three heat tolerant sweet pepper hybrids were identified in AVRDC trials. Seed of hybrids and their inbred lines were multiplied.</li> </ul>

## ACHIEVEMENTS

<p><b>Activity 1.4</b></p> <p>Develop short-day red onions and yellow onions for improved yield, extended shelf-life, and/or Stemphylium resistance</p>	<ul style="list-style-type: none"> <li>Final seed production of onion lines at the Center's headquarters completed; operations phased out</li> <li>Selected open pollinated (OP) onion lines introduced to Mali from Headquarters, and evaluated for adaptation in West Africa</li> <li>Seed increase of 10-20 open pollinated lines for multilocation trials in West/East Africa and bulk seed production of uniform varieties from AVRDC-HQ and reselections in Mali</li> </ul>	<ul style="list-style-type: none"> <li>Seed of most <i>Allium</i> accessions and breeding lines were produced and seed moved to the genebank for medium term storage.</li> <li>Three trials were conducted including a total of 48 AVRDC onion lines (red or yellow bulb types), and 4 yellow and 3 red lines were identified for seed multiplication.</li> <li>115 g seed were produced from a total of 14 onion lines. Mother bulb selection was carried out for 12 local varieties and bulbs are in ambient storage prior to selection and planting for seed production.</li> </ul>
<p><b>Activity 1.5</b></p> <p>Develop and distribute heat-tolerant broccoli and Chinese cabbage varieties</p>	<ul style="list-style-type: none"> <li>Evaluate 60 new broccoli hybrids, multiply seed of promising hybrids, and, identify promising parental lines</li> <li>Test 20 new Chinese cabbage hybrids, multiply seed of promising hybrids and identify promising parental lines</li> </ul>	<ul style="list-style-type: none"> <li>158 broccoli entries were evaluated for heat tolerance and quality traits in summer trials. Fourteen hybrids and 1 open pollinated lines yielded over 10t/ha, but all matured later than 50 days after transplanting. Ten hybrids were selected for 2013 advance yield trials.</li> <li>81 Chinese cabbage entries were evaluated for heat tolerance and quality traits in summer trials in Taiwan. One hybrid demonstrated yield over 10 t/ha and eight hybrids selected based on high yield (over 20 t/ha) and early maturity (less than 40 day after transplant) for 2013 advance yield trials.</li> </ul>
<p><b>Activity 1.6</b></p> <p>Develop improved vegetable soybean and mungbean with improved nutritional and flavor qualities</p>	<ul style="list-style-type: none"> <li>Seed multiplication and distribution of 10-15 basmati and super-nodulating vegetable soybean lines</li> <li>BC<sub>3</sub> populations evaluated for methionine content, additional backcrosses carried out, and molecular markers associated with the high methionine trait developed</li> <li>Database developed for legume breeding lines using Agrobase and ICIS</li> </ul>	<ul style="list-style-type: none"> <li>Elite vegetable soybean lines were distributed to national partners in India, Nepal, Lao, Vietnam, South Africa and Rwanda.</li> <li>BC<sub>1</sub>F<sub>2</sub> &amp; BC<sub>2</sub>F<sub>1</sub> population (NM 94 x GB No. 3-1) and F<sub>3</sub> population (NM 94 x VM 2164) were screened and high methionine lines were identified. A total of 273 polymorphic SSR markers was developed in NM 94 x GB No. 3-1 population. Segregation distortion was detected.</li> <li>Legume lines were maintained in both Agrobase and ICIS.</li> </ul>
<p><b>Activity 1.7</b></p> <p>Develop cucumber lines for improved horticultural traits, disease resistance, good fruit quality, and high gynoecy</p>	<ul style="list-style-type: none"> <li>60-80 F<sub>7</sub> lines of bitter-free and high gynoecy of the South and Southeast Asian types evaluated</li> <li>20-40 F<sub>6</sub> lines of bitter free and high gynoecy of the South and Southeast Asian type evaluated and advanced</li> </ul>	<ul style="list-style-type: none"> <li>Seven F<sub>7</sub> lines were selected for preliminary yield trials</li> <li>Further work on this component is discontinued</li> </ul>
<p><b>Activity 1.8</b></p> <p>Develop disease resistant and high quality pumpkins (<i>Cucurbita moschata</i>)</p>	<ul style="list-style-type: none"> <li>20-35 F<sub>6</sub> lines for yield, fruit quality and field resistance to diseases evaluated and advanced</li> <li>Zucchini yellow mosaic virus resistant <i>C. moschata</i> BC<sub>6</sub>S<sub>1</sub> populations evaluated and advanced</li> <li>20-30 F<sub>3</sub> and 30-40 F<sub>4</sub> families derived from elite hybrids evaluated and advanced</li> </ul>	<ul style="list-style-type: none"> <li>Sixteen F<sub>7</sub> lines were selected for preliminary yield trials</li> <li>BC<sub>6</sub>S<sub>1</sub> lines resistant to ZYMV were selected for generation advance</li> <li>24 F<sub>5</sub> families were selected for evaluation and generation advance</li> </ul>
<p><b>Activity 1.9</b></p> <p>Develop bitter gourds possessing improved yield, earliness, good fruit quality and resistance to diseases/insects</p>	<ul style="list-style-type: none"> <li>60 F<sub>4</sub> and 40-50 F<sub>5</sub> families derived from elite hybrids evaluated and advanced</li> <li>Multilocation trials of elite bitter gourd germplasm and commercial lines in India, Tanzania and Taiwan conducted to evaluate the effects of environment, ripening stage, local postharvest management on level of nutrients and anti-diabetic compounds</li> </ul>	<ul style="list-style-type: none"> <li>26 F<sub>6</sub> lines were selected for evaluation and generation advance</li> <li>Two trials of commercial cultivars were carried out in Taiwan, Tanzania and south India.</li> </ul>

**Output 2:** Indigenous vegetables improved for productivity, quality, and nutrient content

**Outcome:** Lines potentially beneficial to farmers and consumers

Activity	Output Targets 2012	Achievements
<p><b>Activity 2.1</b></p> <p>Develop indigenous vegetables with superior horticultural traits</p>	<ul style="list-style-type: none"> <li>Promising lines of African eggplant, African nightshade and amaranth evaluated for horticultural traits and organoleptic/nutritional qualities in Tanzania</li> </ul>	<ul style="list-style-type: none"> <li>The work was shifted to breeder seed production of the seven African indigenous vegetables released in 2011</li> </ul>
<p><b>Activity 2.2</b></p> <p>Evaluation, seed multiplication, and distribution of elite indigenous vegetables</p>	<ul style="list-style-type: none"> <li>5-10 elite lines of amaranth, roselle, jute mallow, kangkong, basella, Malabar spinach, and spider plant evaluated for horticultural, nutritional and anti-nutritional traits, and seed of selected lines/ accessions increased for international distribution</li> </ul>	<ul style="list-style-type: none"> <li>Elite accessions seeds of 9 amaranth, 13 roselle, 4 jute mallow, and 3 spiderplant were increased. Multiplication of selected kangkong accessions is ongoing. Ninety seven Malabar spinach (<i>Basella</i> spp.) accessions are undergoing seed multiplication and horticultural assessment for future flood tolerance and nutrition studies.</li> </ul>

**Output 3:** Vegetable variety testing networks and improved seed systems developed

**Outcome:** Improved distribution, evaluation, release, and seed production of AVRDC-bred varieties leading to (1) better understanding of genotype-environment interactions, (2) availability of traits critical for particular agroecosystems and markets (3) streamlined variety release procedures, and (4) more efficient vegetable seed production

Activity	Output Targets 2012	Achievements
<p><b>Activity 3.1</b></p> <p>Assemble and internationally distribute elite vegetable lines</p>	<ul style="list-style-type: none"> <li>Global distribution and testing of AVRDC chili pepper, sweet pepper, tomato, leafy crucifer and other AVRDC-developed lines continued</li> </ul>	<ul style="list-style-type: none"> <li>A total of 186 tomato lines were sent to 35 countries and 43 indigenous vegetable lines were sent to 8 countries. Seeds of 50 hot and sweet pepper breeding lines were made available to more than 500 cooperators around the world</li> </ul>
<p><b>Activity 3.2</b></p> <p>Analyze and review of multi-environment testing of AVRDC-improved germplasm</p>	<ul style="list-style-type: none"> <li>Results of multi-location testing of tomato, sweet pepper, chili lines in Central America analyzed and implications for breeding assessed</li> <li>Vegetable variety trials and implications for breeding and variety release analyzed and summarized</li> </ul>	<ul style="list-style-type: none"> <li>Analyzed data for Nicaragua and Honduras was received from University of Wisconsin.</li> <li>Tomato lines CLN2498D and CLN2498E were released as male parents of hybrids 'Arka Rakshak' and 'Arka Samrat', respectively, in India. Analysis of 10 chili pepper lines evaluated at 8 locations was completed and preparation of draft manuscript is ongoing</li> </ul>
<p><b>Activity 3.3</b></p> <p>Develop on-line seed catalog to facilitate seed requests for AVRDC-improved vegetables</p>	<ul style="list-style-type: none"> <li>On-line seed catalogs for tomato, pepper, and soybean updated</li> <li>On-line seed catalogs for root stocks, Chinese cabbage, leafy <i>Brassica</i>, selected indigenous vegetables developed</li> </ul>	<ul style="list-style-type: none"> <li>The cherry tomato online database was updated</li> <li>On-line seed database for eight selected elite leafy <i>Brassica</i> lines were developed</li> </ul>

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<p><b>Activity 3.4</b></p> <p>Monitor and assess variety release, commercialization and adoption of AVRDC-bred lines</p>	<ul style="list-style-type: none"> <li>Commercialization of newly developed AVRDC varieties by seed companies in Tanzania, Cameroon, Mali and neighboring countries monitored</li> <li>Release and seed production of AVRDC lines monitored in Central Asia and Caucasus</li> </ul>	<ul style="list-style-type: none"> <li>25 vegetable lines (3 tomato, 5 chili pepper, 4 African eggplant, 1 okra, 6 African nightshade, 2 Amaranths and 4 jute mallow) await registration for variety release in Cameroon. The delay was due in part to replacement of the Minister of Agriculture. Several AVRDC lines were given to selected seed companies in Cameroon to start scaling-up.</li> <li>Nine AVRDC lines were released in Central Asia and the Caucasus (2 tomato, 2 chili, 3 sweet pepper, 2 vegetable soybean, and 2 mungbean)</li> </ul>
<p><b>Activity 3.5</b></p> <p>Use male sterility to improve the efficiency of hybrid vegetable seed production</p>	<ul style="list-style-type: none"> <li>Establish Cytoplasmic Male Sterility (CMS) and maintainer versions of 'Jupiter' sweet pepper</li> <li>CMS versions of additional elite chili and sweet lines developed</li> </ul>	<ul style="list-style-type: none"> <li>BC<sub>4</sub>F<sub>2</sub> populations of 9 crosses possessing sterile cytoplasm in sweet pepper background and segregating for restoration-of-fertility are in the field for further selection and advance</li> <li>One chili CMS version was developed for future hybrid development</li> </ul>



**AVRDC BREEDS VEGETABLES WITH BETTER TOLERANCE TO HEAT, DROUGHT, PESTS AND DISEASES. IMPROVED VARIETIES BASED ON AVRDC GERMLASM HELP FARMERS IN INDIA AND BANGLADESH HARVEST MORE AND BETTER QUALITY FRUIT FOR MARKET SALE, INCREASING FAMILY INCOME AND ENSURING A MORE STEADY SUPPLY OF NUTRITIOUS VEGETABLES.**

## PRODUCTION: Safe and sustainable vegetable production systems

**Output 1:** Integrated pest management technologies developed/validated

**Outcome:** Integrated pest management technologies and related information to manage major vegetable pests ready to be disseminated to national agricultural research and extension systems, nongovernmental organizations, and small-scale farmers

Activity	Output Targets 2012	Achievements
<p><b>Activity 1.1</b></p> <p>Diagnose and characterize major insect pests</p>	<ul style="list-style-type: none"> <li>Species identity and phylogenetic relationship of the genus <i>Maruca</i> occurring on vegetable legumes in South Asia, Southeast Asia and sub-Saharan Africa established</li> <li>Association of molecular variations in the <i>Maruca</i> populations with host plants and geographical origins in South Asia, Southeast Asia and sub-Saharan Africa determined</li> <li>Phylogenetic relationship of eggplant fruit and shoot borer in Southeast Asia and South Asia established</li> </ul>	<ul style="list-style-type: none"> <li>Legume pod borer (<i>Maruca vitrata</i>) populations were collected from eight countries in Asia and two countries in Africa from 20 host plant species covering 13 genera. The African samples constituted a single clade while the Asia ones constituted six clades. Several Asian <i>cox1</i> variants group with the African populations.</li> <li><i>M. vitrata</i> populations in Asia and Africa responded differently to the same blend of sex pheromone lures. A full-length PBAN cDNA (6148 bp) was isolated from <i>M. vitrata</i> samples.</li> <li>Eggplant fruit and shoot borer (<i>Leucinodes orbonalis</i>) populations were collected from seven countries in Asia. The results revealed two clades in the phylogenetic tree for samples from Bangladesh, India, Lao PDR, Philippines, Taiwan and Thailand in one clade and those from Vietnam in another clade.</li> </ul>
<p><b>Activity 1.2</b></p> <p>Develop integrated pest management technologies for major insect pests</p>	<ul style="list-style-type: none"> <li>Parasitism of major parasitoids (<i>Therophilus marucaae</i> and <i>Phanerotoma philippinensis</i>) on legume pod borer determined</li> <li>Most effective sex pheromone blends against legume pod borer in South Asia, Southeast Asia and sub-Saharan Africa identified</li> <li>Trap crop strategy for fruit worm (<i>Helicoverpa armigera</i>) on tomato validated in Taiwan</li> </ul>	<ul style="list-style-type: none"> <li>A female parasitoid <i>P. philippinensis</i> could parasitized about 70% of <i>M. vitrata</i> eggs laid on yard-long bean under greenhouse conditions. The most preferred stage was one to two days old eggs of <i>M. vitrata</i>. One to three days old female parasitoids inflicted higher parasitism. Successful emergence from the parasitized eggs had an inverse relationship with the host egg density.</li> <li>Two sex pheromone blends tested in Taiwan, Thailand and Vietnam attracted only very few <i>M. vitrata</i> adult males. However, the blend with major component alone attracted male moths of <i>Spodoptera litura</i> (a secondary pest on yard-long bean) and other non-target lepidopteran pests.</li> <li>Results of the study indicated the possibility of using <i>Solanum viarum</i> as a dead-end trap crop.</li> </ul>
<p><b>Activity 1.3</b></p> <p>Diagnose and characterize major bacterial and fungal pathogens</p>	<ul style="list-style-type: none"> <li>Usefulness of molecular markers associated with virulence of phylotype I strains of <i>Ralstonia solanacearum</i> on tomato in strain profiling determined</li> <li>Virulence of Phylotype II/biovar 2/race 3 strains of <i>R. solanacearum</i> on tomato, eggplant and pepper determined</li> <li><i>Colletotrichum</i> species associated with chili pepper anthracnose in Indonesia (East Java and Bali) identified</li> </ul>	<ul style="list-style-type: none"> <li>Four virulence related genes selected to be used in multilocus sequence typing on a Taiwanese <i>R. solanacearum</i> population.</li> <li>Virulence of 45 race 3/biovar 2 potato strains has been evaluated on tomato, eggplant and pepper. The virulence on tomato and eggplant increased with the increase of temperature. The strains were not virulent on pepper.</li> <li>With the addition of 17 <i>Colletotrichum</i> isolates from East Java and Bali, it is confirmed that <i>C. acutatum</i> is the predominant species.</li> </ul>

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<p><b>Activity 1.4</b></p> <p>Develop and validate integrated disease management technologies for major bacterial and fungal diseases</p>	<ul style="list-style-type: none"> <li>Control efficacy of phosphoric acid salt on tomato foliar diseases evaluated</li> <li>Control efficacy of plant activator and tolerant variety on tomato late blight evaluated</li> <li>Effect of biochar as an amendment in potting mixture on plant growth and induced resistance in tomato evaluated</li> </ul>	<ul style="list-style-type: none"> <li>Preliminary pot trials demonstrated no obvious control effect on tomato black leaf mold, gray leaf spot and bacterial spot.</li> <li>Three plant activators, i.e. BION, Resist, and PAS, showed significant control effect on late blight on tomato varieties that contained resistance genes.</li> <li>Addition of biochar in potting mixture showed no effect on seedling growth of tomato, broccoli, and pepper.</li> </ul>
<p><b>Activity 1.5</b></p> <p>Detect, characterize and explore integrated management strategies for major viral diseases</p>	<ul style="list-style-type: none"> <li>The important viruses, especially begomoviruses, infecting or emerging in vegetable crops in Asia and Africa identified and monitored</li> <li>Genetic diversity of cucurbit-infecting begomoviruses in Taiwan studied</li> <li>An infectious clone of a cucurbit-infecting begomovirus from Taiwan developed</li> </ul>	<ul style="list-style-type: none"> <li>Bi-partite <i>Mungbean yellow mosaic virus</i> was identified on mungbean samples from central-south Vietnam and <i>Bhendi yellow vein mosaic virus</i> (BYVMV, Begomovirus) on okra plants from Thailand. Up to three different species of begomovirus in mixed infections, including the newly identified '<i>Sauropus leaf curl virus</i>' were found on the indigenous leafy vegetable known as sweet leaf bush (<i>Sauropus androgynous</i>). Evidence suggests that <i>Sauropus</i> is a good perennial, overwintering host where begomoviruses can multiply and recombine to potentially form more aggressive or virulent types.</li> <li>Phylogenetic analysis of the genome sequences of samples with yellow leaf curl symptoms from different cucurbit species begomoviruses showed them all to be <i>Squash leaf curl Philippines virus</i> (SqLCPHV) with relatively little genetic diversity, suggesting a relatively recent single introduction of the virus to Taiwan.</li> <li>Partial dimmers of the DNA-A and DNA-B components of SqLCPHV are being cloned into a modified Ti plasmid to form infectious clones that can be inoculated to test plants by agrobacterium inoculation. Preliminary results suggest that the DNA-A alone of a Taiwan strain can induce very mild symptoms in squash plants.</li> </ul>

**Output 2:** Integrated crop and soil fertility management technologies developed/validated

**Outcome:** Integrated crop and soil fertility management technologies and related information to enhance and sustain vegetable productivity ready to be disseminated to NARES, NGOs, and small-scale farmers

Activity	Output Targets 2012	Achievements
<p><b>Activity 2.1</b></p> <p>Develop technologies to improve soil nutrient use efficiency and soil sustainability</p>	<ul style="list-style-type: none"> <li>Simple, quick testing kits for determining pH, nitrate-N, P and K in soils validated</li> <li>General guidelines of simple soil health assessment suitable for smallholder vegetable production developed</li> <li>Effects of biochar application on soil nutrient retention determined</li> </ul>	<ul style="list-style-type: none"> <li>Simple, quick testing kits were validated using soils collected at farmers' fields in Taiwan. pH strip with water extraction can be recommended for pH test, Cardy meter and MQ-strip with water extraction (lower cost) for N test, and RQ meter with Ca lactate extraction for K test. No suitable quick test method is recommended to determine soil P.</li> <li>Guideline and pictorial field guide were developed for smallholder vegetable production in Fiji. Twelve soil health indicators were selected and survey was conducted. Summarized report is in being written.</li> <li>Using a soil column method, preliminary results of the study indicated that biochar briquetting might increase inorganic N retention in soil. Further investigations are in progress.</li> </ul>



**Output 3:** Improved vegetable production technologies integrated, disseminated and impact assessed

**Outcome:** Farmers adopt new technologies that result in improved farm productivity and sustainability, incomes and farm livelihoods

Activity	Output Targets 2012	Achievements
<p><b>Activity 3.1</b></p> <p>Identify major constraints and determine site-specific dissemination strategies in targeted regions</p>	<ul style="list-style-type: none"> <li>• A check-list on how to effectively implement technology dissemination projects published</li> <li>• Participatory appraisals of vegetable farming conducted in targeted countries, and dissemination strategies determined for integrated crop management technologies</li> <li>• Major insect and mite pests on selected vegetables in West Asia identified</li> </ul>	<ul style="list-style-type: none"> <li>• The checklists and explanatory narratives for each of the eleven activities are over 90% completed and is planned to be published soon.</li> <li>• The nature of development projects commencing in 2012 do not require participatory appraisals.</li> <li>• Not conducted for lack of financial resources.</li> </ul>
<p><b>Activity 3.2</b></p> <p>Adapt integrated production technologies for targeted systems or regions</p>	<ul style="list-style-type: none"> <li>• Integrated pest management packages and improved vegetable production technologies (e.g. composting, balanced fertilization and crop rotations) for target crops under open-field and net house production systems in Jharkhand and Punjab India adopted</li> <li>• Integrated crop management technologies for tomato and pepper (e.g. balanced fertilization, starter solution technology and soil management) adapted in Indonesia</li> <li>• Integrated crop management technologies (e.g. insect exclusion net, drip irrigation etc.) evaluated and adapted in year-round vegetable production systems in Fiji, Solomon Islands and Samoa</li> </ul>	<ul style="list-style-type: none"> <li>• Pot and nethouse trials in Punjab, India showed mustard cake amendment significantly reduce galling severity of root knot nematode on eggplant.</li> <li>• A trial on adapting starter solution technology and balanced fertilization using significantly lower dose of fertilizers for chili pepper in Indonesia demonstrated no yield reduction. Therefore, the starter solution is a more efficient fertilizer application strategy.</li> <li>• Task postponed, awaiting importation of the net material.</li> <li>• Tomato varieties: LBR-17, L03708, L05983 and L06193 were found to be suitable as rootstocks and have been recommended for tomato production in Uzbekistan.</li> </ul>
<p><b>Activity 3.3</b></p> <p>Strengthen capacity of local partners and farmers to promote technology adoption</p>	<ul style="list-style-type: none"> <li>• Extension and training materials published on various vegetable production technologies</li> <li>• Key vegetable production skills of farmers that need to be strengthened in Solomon Islands and Fiji identified</li> <li>• Four issues of <i>Feedback from the Field</i> published and mature technologies database updated</li> </ul>	<ul style="list-style-type: none"> <li>• Planting instructions for 15 crops and two grafting videos were published on the AVRDC website and on YouTube. Thirty extension publications in English, Hindi and Punjabi were produced for distribution to farmers in Jharkhand and Punjab, India.</li> <li>• Farmer surveys were conducted in Sigatoka valley, Fiji. Current practices were documented.</li> <li>• Four issues of <i>Feedback from the Field</i> were published on the AVRDC website and Facebook.</li> </ul>
<p><b>Activity 3.4</b></p> <p>Understand farmers' behavior, cost-benefit, and constraints/opportunities of technology adoption</p>	<ul style="list-style-type: none"> <li>• Socioeconomic factors affecting bitter gourd production in selected regions of India analyzed</li> <li>• Socioeconomic factors affecting net house-based vegetable farming in Punjab, India analyzed</li> <li>• Socioeconomic analysis of vegetable production practices in East Java and Bali, Indonesia analyzed and documented</li> </ul>	<ul style="list-style-type: none"> <li>• A quantitative household survey was conducted in two sub-districts of Coimbatore, India with 100 respondents. The major production constraints identified included insect pests, high labor wage, lack of credit for inputs, disease, and lack of improved varieties.</li> <li>• The baseline economic study has been completed in Punjab, India and a draft was published. Further interviews with 360 households were conducted to review production practices for home garden and markets.</li> <li>• A baseline survey was completed in East Java and Bali with 362 farmers and data was analyzed. Documentation of results is in progress.</li> </ul>

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### Activity 3.5

Understand the impact of improved technologies on production systems and livelihoods

- Baseline survey on extent of uses, production and consumption levels of amaranth in Tanzania conducted and documented
- Baseline status of current vegetable variety use and source of planting material of target crops in Bangladesh analyzed and documented
- Total of 164 respondents were interviewed in Arusha and Kilimanjaro regions, Tanzania. Majority of amaranth growers in urban and peri-urban areas produce it as the primary source of income and for home consumption. The major production and marketing constraints included post-harvest loss and lack of market information and facility.
- Surveys were conducted and data collection completed from 360 respondents from Jessore, Barisal and Faridpur, Bangladesh. A combination of qualitative and quantitative methods was used on farm household surveys. Data analysis and report write up are in progress.



**POSTHARVEST SORTING AND PACKAGING ADD VALUE TO THE VEGETABLE HARVEST. PARTICIPANTS IN AVRDC'S INTERNATIONAL VEGETABLE TRAINING COURSE VISITED PACKHOUSES AND PROCESSORS IN THAILAND TO LEARN HOW FRESH OKRA AND OTHER PRODUCE IS GRADED FOR SIZE, COLOR, AND OTHER QUALITY CHARACTERISTICS.**

## CONSUMPTION: *Balanced diets through increase access to and utilization of nutritious vegetables*

**Output 1** : Knowledge of consumer behavior and nutritional properties of vegetables enhanced

**Outcome:** Research communities and development practitioners become aware and better understand consumers' attitude towards health, food safety and vegetable consumption as well as the nutritional and functional values of vegetables.

Activity	Output Targets 2012	Achievements
<p><b>Activity 1.1</b></p> <p>Assess consumption nutrition related outcomes of vegetable gardeners and consumers in Asia and sub-Saharan Africa</p>	<ul style="list-style-type: none"> <li>• Baseline surveys and data collections conducted to assess knowledge on vegetable consumption, consumer attitude and preferences, and the nutritional and socio-economic outcomes of vegetable consumption in India, Bangladesh, Tanzania and Mali</li> <li>• Participatory impact pathway appraisal framework for vegetables in improving incomes, nutrition and health in Bangladesh developed</li> <li>• Comprehensive database on food and nutritional security of urban and peri-urban communities of selected project sites in Greater Bangkok identified</li> </ul>	<ul style="list-style-type: none"> <li>• Analysis on characterization of vegetable production, marketing and vegetable patterns is in progress and expected to be completed in 2013</li> <li>• Value chain study on tomato and pumpkin was conducted and report on impact pathways was finalized. The study revealed that farmers are not getting fair prices due to market syndication effect formed by market intermediaries. Post-harvest loss of selected crops was 25-50 percent, due to improper handling, packaging, low-level technology, and lack of cold storage.</li> <li>• Centralized geographic information systems database was created. Work on refining digital mapping of attributes of focus vegetables is in progress.</li> </ul>
<p><b>Activity 1.2</b></p> <p>Study nutritional and functional values and benefits of vegetables from sub-Saharan Africa and Asia</p>	<ul style="list-style-type: none"> <li>• Nutritional values of vegetables commonly consumed in Mali evaluated</li> <li>• Information on anti-and pro-inflammation properties of selected indigenous vegetables published and potential food intervention approach identified to enhance immune function</li> <li>• Anti-diabetic activities and compounds in bitter gourd evaluated, accessions high in anti-diabetic activity selected for efficacy studies, and optimal preparation method and dosage investigated for using bitter gourd in diabetes management in animal model</li> </ul>	<ul style="list-style-type: none"> <li>• Nutritional values for amaranth, African eggplant, okra, roselle, chili pepper, and tomato evaluated and nutritional information made available. Work on other vegetables is postponed due to the on-going political instability in Mali</li> <li>• Study completed and results documented as part of MSc student thesis. Most of vegetables did not showed consistent results in anti- or pro-inflammatory effects. They may have neutral or both effects.</li> <li>• Anti-diabetic activities and compounds in bitter gourd evaluated using methanol extracts. Accessions high in anti-diabetic activity were selected for efficacy studies with mice. Optimal preparation method and dosage for humans were investigated and pre-tested via a dietary intervention study.</li> </ul>

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### Output 2. Dietary strategies and food based intervention packages developed

**Outcome:** AVRDC – The World Vegetable Center, national agricultural research and extension system and non-governmental organizations promote home, school and community gardening, distribute seed kits and advocate more nutritionally effective use of vegetables.

Activity	Output Targets 2012	Achievements
<p><b>Activity 2.1</b></p> <p>Develop home, school and community garden packages for poor households in Asia and sub-Saharan Africa for technology adaptation and increased access to vegetables</p>	<ul style="list-style-type: none"> <li>Nutritional seed kits for home, school and community gardens distributed in selected locations of sub-Saharan Africa, Asia and Pacific</li> <li>Participatory demonstration and pilot projects on vegetable gardens in selected schools and communities in sub-Saharan Africa, Asia and Pacific established</li> <li>A regional experts workshop in Bangkok, Thailand to discuss strategies for establishing home, school and other public facility vegetable gardens in the ASEAN region conducted</li> </ul>	<ul style="list-style-type: none"> <li>Over 20,000 seed kits were distributed in various regions for both disaster recovery (in India and Tanzania) and demand creation purposes including home garden recipients.</li> <li>Concept of school gardens was introduced in Indonesia and Piedmont area of Uzbekistan as part of the Center's nutritional promotional activities. Nutritional education and year round cropping calendar for school gardens were also developed.</li> <li>Workshop was conducted, involving over 200 participants of government and non-governmental organizations from 25 countries. 53 scientific papers and 34 posters were presented during the workshop.</li> </ul>
<p><b>Activity 2.2</b></p> <p>Develop nutritious vegetable seed kits tropical and sub-Saharan Africa and Asia</p>	<ul style="list-style-type: none"> <li>Existing seed stocks in Taiwan, India, Tanzania and Mali made available for distribution in response to future disasters in sub-Saharan Africa and Asia, in exchange for funding to replenish seed stocks</li> <li>Easy-to-understand instructions on cultivation, field management, and food preparation in various local languages in sub-Saharan Africa and Asia prepared for publication</li> </ul>	<ul style="list-style-type: none"> <li>Existing seed stocks were distributed to flood affected victims in India and Tanzania</li> <li>Instructions on cultivation, field management, and food preparation of indigenous vegetables were prepared in local languages for distribution in Thailand, India, Tanzania, Mali and Central Asia</li> </ul>
<p><b>Activity 2.3</b></p> <p>Develop dietary strategies, nutrition-improved recipes and food preparation methods based on traditional diet and food practices for promotion of vegetables and nutrition to household women in Asia and sub-Saharan Africa</p>	<ul style="list-style-type: none"> <li>Nutrition leaflets, posters, booklets and recipes developed, printed and distributed in Punjab and Jharkhand, India and in Mali</li> <li>Bitter gourd recipes developed based on local preparation methods and anti-diabetic study for promotion in diabetic communities in India, Tanzania, Taiwan and Thailand</li> <li>Locally adaptable dietary strategies with increased consumption of sweet potato and vegetables developed for poor households in south Bangladesh</li> </ul>	<ul style="list-style-type: none"> <li>Nutrition-improved and modified food practices and recipes were prepared and promoted in Punjab and Jharkhand, India. Farmer beneficiaries received appropriate training in 30 developed recipes. Recipe-based nutritional promotional strategies including use of food pyramid in Mali were conducted. Recipes developed have been displayed at public and social gatherings, disseminated via mass media and even through songs.</li> <li>Bitter gourd cooking recipes for managing type II diabetes was developed for Taiwan, India and Tanzania. A non-bitter recipe drink with food additives within the range of the European and American allowances has also been developed. The recipe meets standard food grade quality</li> <li>Dietary food consumption patterns were evaluated, and nutrition gap and potential intervention and promotion strategies were identified. Nutritional promotion campaigns were currently being tested in collaboration with national partners.</li> </ul>

**Output 3:** Approaches to enhanced market efficiency and access developed, post-harvest losses minimized and vegetable supply chains strengthened

**Outcome:** Small-scale farmers and other value chain actors in Africa, Asia and the Pacific benefitted from improved market coordination along vegetable supply chains, improved post-harvest practices as well as from enhanced research capacities and networks

Activity	Output Targets 2012	Achievements
<p><b>Activity 3.1</b></p> <p>Analyze components of supply chains and marketing systems of vegetables in sub-Saharan Africa, Asia and Pacific</p>	<ul style="list-style-type: none"> <li>Marketing systems of bitter gourd in selected locations in India and Tanzania assessed.</li> <li>Baseline data on production, post-harvest handling practices and consumption of vegetables in Thailand established and vegetable value chain study conducted in East Java and Bali, Indonesia</li> <li>Feasibility of strengthening existing linkages between vegetable value chain actors through facilitating the setting up of stakeholder forums in Mali assessed</li> </ul>	<ul style="list-style-type: none"> <li>Marketing system of bitter gourd in India and Tanzania was analyzed. Results showed that there are more structured marketing systems in India compared to those in Tanzania where marketing activities are largely ad-hoc and spatially disperse</li> <li>Baseline study on production, post-harvest handling practices and consumption of vegetables in Thailand was completed. Value chain study in Indonesia was completed.</li> <li>Task partially achieved due to a 5-month suspension of project activities because of the on-going political instability in Mali</li> </ul>
<p><b>Activity 3.2</b></p> <p>Facilitate the establishment of enhanced market coordination mechanisms for vegetable supply in sub-Saharan Africa, Asia and Pacific</p>	<ul style="list-style-type: none"> <li>Vegetable marketing systems and consumer demand of high value vegetables in Solomon and Fiji Islands analyzed and documented; and effective linkages along globally important and indigenous vegetables value chains in Tanzania, Cameroon and Mali enhanced through various demand creation activities</li> <li>Three enhanced market pilot schemes under the Participatory Guarantee System (PGS) model, tailored to demands of specific market segments, in the Solomon and Fiji Islands designed for field testing and validation.</li> <li>Rapid assessment of public, private, and civil society contributions to value chain development of selected vegetables for improved nutrition in Bangladesh conducted</li> </ul>	<ul style="list-style-type: none"> <li>Results of the study showed a high demand for quality produce that is difficult to grow all year round. A participatory guaranteed system model was introduced to link buyers to sellers and reduce high postharvest losses as a viable alternative to link farmers to institutional consumers while stabilizing farm household incomes.</li> <li>One field day to showcase improved production technologies with eight onion varieties was successfully conducted in Mali. A total of 70 farmers participated.</li> <li>Stakeholder workshop for needs assessment and exchange of market information was held, involving input suppliers, hoteliers, farmer representatives, extension staff, and other value chain actors. Preliminary testing and validation of best bet models completed.</li> <li>Rapid assessment for baseline study was conducted. Preliminary report of the study is available</li> </ul>
<p><b>Activity 3.3</b></p> <p>Develop and enhance training curricula and materials on proper post-harvest management and marketing skills for trainers in Asia, sub-Saharan Africa and Pacific</p>	<ul style="list-style-type: none"> <li>International Vegetable Training Course (IVTC) curricula and lecture/ training materials on vegetable post harvest, marketing and nutrition at ESEA office reviewed and updated annually</li> <li>Training materials in marketing and post-harvest handling activities adapted for program intervention beneficiaries in of Mali developed</li> <li>Capacity strengthening of National Agricultural Research and Extension Systems (NARES) partners in use of collective action and participatory approaches for vegetable marketing and post-harvest handling practices in Bangladesh conducted</li> </ul>	<ul style="list-style-type: none"> <li>Curricula and training materials were reviewed and updated in the course of the year. Training courses were completed, evaluation and review were finalized.</li> <li>Task partially achieved due to a 5-month suspension of project activities because of the on-going political instability in Mali</li> <li>Specialized training courses on vegetable processing and preservation were delivered to project beneficiaries in Bangladesh and Tanzania.</li> </ul>

## ACHIEVEMENTS

<p><b>Activity 3.4</b></p> <p>Strengthen post-harvest research capacity of national partners through trainings and awareness raising on post harvest losses and post harvest research in national and regional level in Asia, Africa and the Pacific</p>	<ul style="list-style-type: none"> <li>• At least 20 participants from Asia trained in vegetable production, post harvest and marketing</li> <li>• Capacities building of NARES program partners in research and training in vegetable post-harvest handling and utilization practices for enhanced nutrition in Mali conducted.</li> <li>• Post-harvest quality and nutritional composition of selected vegetable varieties in Bangladesh analyzed</li> </ul>	<ul style="list-style-type: none"> <li>• Thirty eight participants from 12 countries were trained in vegetable production, post harvest and marketing</li> <li>• Training courses were conducted in Mali to enhance capacity of NARES program partners.</li> <li>• Nutritional values of some common vegetables such as tomato and pumpkin evaluated.</li> </ul>
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**Output 4:** Policy recommendations with an aim to increase vegetable consumption developed, capacity strengthened and technology and knowledge disseminated

**Outcome:** Consumers are aware of the health-promoting benefits of increased utilization of vegetables through better access to nutritional education information, enhanced capacities of national agricultural research and extension systems and non-governmental organizations and improved policy support

Activity	Output Targets 2012	Achievements
<p><b>Activity 4.1</b></p> <p>Conduct training courses and promotion campaigns to increase production, utilization and consumption of nutrient-rich vegetables in Asia, sub-Saharan Africa and Pacific</p>	<ul style="list-style-type: none"> <li>• Training courses on vegetable home garden production, processing and preservation delivered to farmers youth, women groups and employees of national agricultural research and extension systems in Asia, Pacific and sub-Saharan Africa</li> <li>• Consumer awareness of vegetable consumption and nutrition effects on health promoted through field days, seed fairs, national agricultural shows and on-farm demonstration plots in sub-Saharan Africa and Asia</li> <li>• Approaches for effectively promoting indigenous vegetable production, consumption (and utilization) explored and implemented in Asia, Pacific and sub-Saharan Africa</li> </ul>	<ul style="list-style-type: none"> <li>• Training courses on home gardens were conducted for over 10,000 beneficiaries in India, Tanzania, and Central Asia</li> <li>• Consumer awareness and market demand creation activities were conducted through a field day, a seed fair and a seed business training course in Tanzania and Mali. Several extension materials were distributed as a complimentary dissemination strategy to farmers in the various regions.</li> <li>• Promotional activities were conducted involving seed fairs, production manuals and training courses in Asia, Pacific and sub-Saharan Africa.</li> </ul>
<p><b>Activity 4.2</b></p> <p>Develop policy briefs on outcome and impact assessment of program interventions in sub-Saharan Africa, Asia</p>	<ul style="list-style-type: none"> <li>• At least one policy brief on best Farmer-Led Seed Enterprise models in Tanzania prepared and disseminated for up-scaling</li> <li>• Impact assessment of tomato grafting technology on production, consumption and household income in the Lam Dong and other neighboring provinces of Vietnam quantified through surveys</li> </ul>	<ul style="list-style-type: none"> <li>• Peer-reviewed publication of comparison of two farmer-led seed enterprise is in press. Draft abstract for policy brief is available.</li> <li>• Study involving shoestring impact evaluation approach (as a result of lack of baseline data) completed. Triangulation approaches used to recall status quo data reference year of 2002. Preliminary results show a 100 percent (n=225) observed adoption rate in the Southern Vietnam as opposed to 48 percent (n=36) in the northern Vietnam. The contribution of grafted tomato to total household income was found to be higher than non-grafted tomato.</li> </ul>

# RESEARCH & DEVELOPMENT PROJECTS: 2012

Support for AVRDC – The World Vegetable Center’s research and development projects comes from a range of donors: national and international institutions, public and private sector organizations, bilateral and multilateral collaborations. In accordance with its Strategic Plan (2011 -2025), AVRDC addresses constraints and utilizes opportunities to enhance production and increase consumption of vegetables. Each project focuses on specific topics along the research and development continuum: advanced and adaptive research for development, implementation of basic and applied development, technology transfer and dissemination.

Project Title	Donor Name	Duration
Strengthening integrated crop management research in the Pacific Islands in support of sustainable intensification of high value-crop production	Australian Centre for International Agricultural Research, Australia	2011 - 2016
A preliminary study to improve income and nutrition in Eastern and Southern Africa by enhancing vegetable based farming and food systems	Australian Centre for International Agricultural Research, Australia	2012 - 2013
Increased resiliency of vulnerable communities in Puri district, Odisha to recurrent floods	COFRA Foundation, Switzerland	2012 - 2014
Enhancing productivity, competitiveness and marketing of traditional African (leafy) vegetables for improved income and nutrition in West and Central Africa	West and Central Africa Council for Agricultural Research and Development	2012 - 2014
Various small research projects	Council of Agriculture, Taiwan	2012 - 2013
Beating Begomoviruses: Better livelihoods for farmers in tropical Asia with begomovirus-resistant tomato, hot pepper and mungbean and integrated disease management	Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany	2012 - 2014
Enhancing horticultural productivity, incomes and livelihoods through integrated management of aphid pests on vegetables in sub-Saharan Africa	Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany	2011 - 2014
Better bittergourd: Exploiting bittergourd ( <i>Momordica charantia</i> , L.) to increase incomes, manage type 2 diabetes, and promote health in developing countries	Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany	2011 - 2014
Less loss, more profit, better health: reducing the losses caused by the pod borer ( <i>Maruca vitrata</i> ) on vegetable legumes in Southeast Asia and sub-Saharan Africa by refining component technologies of a sustainable management strategy	Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany	2010 - 2013
Overcoming conservation and germination problems of selected indigenous vegetables	Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany	2012 - 2014
Network for knowledge transfer on sustainable agriculture technologies and improved market linkages in South and Southeast Asia (SATNET Asia)	EuropeAid	2011 - 2014
Characterization of thrips species occurring on major vegetable crops in Indonesia	East West Seed, Indonesia	2012
African-German partnership to enhance resource use efficiency in urban and peri-urban agriculture for improved food security in West African cities	Federal Ministry for Education and Research, Germany	2012 - 2015
Diversifying food systems: Learning and innovation in horticultural value chains to improve the livelihood situation of rural and urban poor in Kenya, Ethiopia and Tanzania	Federal Ministry for Education and Research, Germany	2012 - 2015
Vegetable seed kits for flood-affected households in Fiji	Government of Fiji	2012 – 2013
Training, technical support and vegetable seeds for enhanced household food production	Helen Keller International	2012 - 2013
Develop a begomovirus-resistant and early blight tomato varieties that will help farmers increase production and income in South Asia and other parts of the tropics	Indus Seeds, India	2011 - 2013

## RESEARCH & DEVELOPMENT PROJECTS

Project Title	Donor Name	Duration
Enhancing productivity, competitiveness and marketing of onion in the Sudano-Sahelian region of Cameroon	International Fund for Agricultural Development, Italy	2012 - 2016
Good seed initiative	Irish Aid, Ireland	2012 - 2013
Screening for development of begomovirus-resistant processing tomato hybrid	Kagome Co. Ltd., Taiwan	2010 - 2013
A training course on vegetable grafting for Qatar	Ministry of Education, Government of Qatar	2012
Characterize and map late blight resistance in wild tomato accessions	National Science Council, Taiwan	2010 - 2013
Studies on durability of resistance trait loci against <i>Ralstonia solanacearum</i> and efficiency of marker-assisted selection	National Science Council, Taiwan	2012 - 2013
Fine-mapping of quantitative trait loci on tomato chromosome 6 associated with resistance to Phylotype I and II strains of <i>R. solanacearum</i>	National Science Council, Taiwan	2012 - 2013
Local adaptation of <i>Ralstonia solanacearum</i> phylotype IIB sequevar 1 strains in Taiwan and identification of their resistance sources in tomato	National Science Council, Taiwan	2012 - 2013
Identification of virus resistance genes in pumpkin and development of the associated marker-assisted selection tools	National Science Council, Taiwan	2012 - 2014
Developing an integrated participatory guarantee scheme in the Pacific Islands in support of sustainable production of high-value vegetable crops	Pacific Agribusiness Research and Development Initiatives, Australia	2011 - 2016
Screening and collection of anthracnose-resistant pepper germplasm and development of high temperature-resistant pepper lines for abnormal climate	Rural Development Administration, Republic of South Korea	2012 - 2013
Improving vegetable production and consumption for sustainable rural livelihoods in Jharkhand and Punjab, India	Sir Ratan Tata Trust, India	2008 - 2013
Vegetables Go to School: Promoting food security and nutrition through school-based approaches	Swiss Agency for Development and Cooperation, Switzerland	2012 - 2013
Production of tomato plants genetically modified to resist Tomato leaf curl Taiwan virus for biosafety assessment and evaluation	Taiwan Food and Drug Administration, Taiwan	2012 - 2013
Value addition of indigenous food crops by low cost sustainable processing: towards poverty reduction, food and nutrition security in sub-Saharan Africa	The Africa-Australia Food Security Initiative, Australia	2011 - 2014
Vegetable seed kits for flood affected urban and peri-urban farming household in Dar es Salaam, Tanzania	United Nations Food and Agricultural Organization	2012 - 2013
Growing vegetables for improved nutrition, empowerment of women and a healthy vegetable value chain in southern Bangladesh	US Agency for International Development, Bangladesh Mission	2012 - 2013
Extension of appropriate postharvest technology in sub-Saharan Africa: A postharvest training and services center	US Agency for International Development, Horticulture Collaborative Research System Program	2012 - 2014
Agricultural innovation project: Scientific research and capacity strengthening to promote agricultural growth, poverty reduction and food security in Pakistan	US Agency for International Development, Pakistan Mission	2012 - 2016
Mobilizing vegetable genetic resources and technologies to enhance household nutrition, income and livelihoods in Indonesia	US Agency for International Development, Indonesia Mission	2010 - 2014
Improving vegetable production and consumption in Mali	US Agency for International Development, Mali Mission	2011 - 2013
Improving nutrient supplies and diet diversity with vegetables in Mali	US Agency for International Development, Mali Mission	2012 - 2013
Postharvest program in Asia and sub-Saharan Africa	US Agency for International Development, USA	2012 - 2013
Africa RISING: Sustainable intensification of cereal-based farming systems in the Sudano-Sahelian zone	US Agency for International Development, USA	2012 - 2016



# GLOBAL SUPPORT

## Office of the Deputy Director General - Research

The Deputy Director General for Research leads the Center's research and development activities, provides vision and direction, and determines strategies, priorities and medium- and long-term goals. During 2012, the Center's Medium-Term Plan 2012-2014, Year in Review 2011 and Annual Report 2011 were completed according to schedule. This annual planning process, linked to the annual research and development Theme meetings and Global Strategic Planning, ensures scientists (irrespective of geographical location) interact, plan and exchange ideas to ensure effective and efficient progress is made towards the Center's goal of achieving prosperity for the poor and health for all.

The Deputy Director General for Research has a key role in leading and facilitating project proposal preparation and fund raising for research and development activities. While many projects are indirectly prepared for submission under the oversight of the Deputy Director General for Research by the Grants and Partnerships Management team, the Deputy Director General for Research had a pivotal role in securing the United States Agency for International Development (USAID) core and postharvest funding (postharvest activities have thus recommenced at the Center to address the 40% or more losses that are recorded postharvest in developing tropical countries) as well as the development and preparation of "Vegetables Go to School," a proposal submitted to the



### DEPUTY DIRECTOR GENERAL - RESEARCH JACKIE HUGHES DEVELOPS STRATEGIES TO ADVANCE THE CENTER'S MISSION.

Swiss Development Corporation (SDC).

The Deputy Director General for Research chaired the Center's Research and Development and Biosafety and Ethics committees and participated in other committees as appropriate to ensure the scientific credibility of the Center.

The Center's research and development support groups report directly to the Deputy Director General for Research:

- The Communications group ensured quality publications, dynamic public relations and good visibility for the Center. The

quality of science and publication of the Center's findings across a range of different media – including refereed journal articles and other scholarly publications, the Center's publications, on-line publications, popular articles, etc. – was assured by close monitoring of the research processes and the documentation of the outputs and outcomes. The Center also held its first 'Writing Week' when all the Center's scientists and support staff were required to dedicate their time to writing manuscripts and publishing their work. The week was appreciated by staff, increased the Center's rate of manuscript submission to refereed journals, and will become an annual event.

- **Monitoring and Evaluation:** The Center's monitoring and evaluation capacity was strengthened during the year in terms of personnel and through training activities.



**THE DEPUTY DIRECTOR GENERAL - RESEARCH ORGANIZED SCIENCE DAY 2012 FOR AVRDC BOARD MEMBERS.**

- Information Technology Services was strengthened through the recruitment of an IT Manager to ensure uninterrupted internet access, email and software/hardware support.
- Biometrics support is critical to assuring the quality of AVRDC's scientific outputs. All Center's researchers work closely with Biometrics to assure that experiments are properly designed and all data correctly analyzed and presented in a credible manner.
- Intellectual property and legal support to the Center's research and development activities, including contractual, genetic resources and public-private partnerships was provided by the Center's intellectual property lawyer based in Malaysia.

The Deputy Director General for Research represented the Center at international fora to raise the profile of the Center's global activities and to strengthen the Center's linkages with donors. These included the Asian Seed Congress

(Pattaya, Thailand), the African Seed Trade Association Congress (Zanzibar), the 7th AARNET Steering Committee meeting (Singapore), SEAVEG 2012 (Chiang Mai, Thailand), AARNET Expert Consultation Workshop (Bangkok, Thailand), and the SDC-Vegetables Go to School Project Planning Workshop (Bangkok, Thailand). The Deputy Director General for Research assessed the scientific excellence and professional quality of research and development staff; this led to the nomination of one of the Center's young scientists for the World Food Prize Borlaug Field Award.

The Deputy Director General for Research worked closely with the Director General, the Deputy Director General for Administration & Services, the Director of Finance and the Director of Human Resources, as well as the Regional Directors, as part of the management team to ensure the success of the Center's research and development efforts. ♦

## Office of the Deputy Director General - Administration & Services

The Office of Deputy Director General for Administration and Services provided leadership and guidance to administration and service offices to ensure efficient and harmonious services required for the implementation of research and development programs, and to support the Director General in host country relations.

Functions under Administration & Services consist of Purchasing, Travel, General Affairs, Food and Dormitory Services, Technical Services, Human Resources and host country liaison.

### PURCHASING

About 2,600 purchase orders and payments for headquarters and regions were processed. Two duty-free permits from the Taiwan Ministry of Foreign Affairs (MOFA) were applied for imported articles for research use. Shipments of personal effects for six departing internationally recruited staff were handled. Online monthly consumption reports were processed for 10 toxic chemicals for the research lab.

### TRAVEL

A total of 514 air tickets were booked and purchased for headquarters and regional staff, board members, candidates, visitors, and family members of internationally recruited staff.

(US\$375,512) Forty-four Taiwan visas for headquarters scientists and 37 for regional scientists, candidates & visitors were applied. Forty-two visas for international trips were applied for headquarters scientists.

#### TECHNICAL SERVICES

About 160 m of field irrigation and drainage ditches were constructed. As a result of reducing the Center's electric power contract capacity from 980 kw to 755 kw in March 2012, NT\$37,552 was saved per month in non-summer seasons (Oct-May) and NT\$50,310 in summer (Jun-Sep). Two and a half hectares of organic rice were planted on fields 82-84; about 20,000 cabbages were harvested and sold to staff. Weather data was downloaded weekly from the Center's newly installed upgraded weather facilities. The Carbon Footprint Committee was provided with relevant data for carbon footprint calculations. The new telephone system at headquarters enables AVRDC staff to receive and make Skype calls through HQ extensions; the service will save costs on international calls

#### FOOD AND DORMITORY SERVICES

A total of 126 guests and 37 students were accommodated. 52 parties were arranged. More than 70 formal coffee breaks were prepared. More than 1100 AVRDC traditional cakes were sold.

#### CHANGE OF OFFICIAL LAND CATEGORY OF AVRDC HEADQUARTERS FARM

AVRDC headquarters land was originally owned by the Taiwan Sugar Corporation. The Taiwan

Government paid Taiwan Sugar NT\$30M to legally use the land for 99 years and let the land to AVRDC with a token rent of NT\$1. The land was categorized as Farm Land and taxation waived to 1995 when the Southern Taiwan Science Park was established. The land category was then changed to Agriculture R&D Land.

Because the property is categorized as Agriculture R&D Land, Taiwan Sugar is obligated to pay land tax of NT\$27M (US\$900,000-US\$1M) a year. Taiwan Sugar paid the land tax from 2007, amounting to NT\$150M (US\$5M). Taiwan Sugar requested the Council of Agriculture (COA) to reimburse the tax as the land is being used by AVRDC, but COA rejected the request. After lengthy consultation, Taiwan Sugar and COA concluded that (a) the tax paid would be negotiated between Taiwan Sugar and COA and (b) to reduce the tax burden, the AVRDC

farm (excluding the land with buildings and facilities) would be changed back to the Farm Land category. COA consulted with AVRDC on land use plans for next 5-10 years. The main campus, including greenhouse areas and the off-campus dormitory area, are considered sufficient for the next 10 years, and AVRDC agreed to having the remaining land changed back to Farm Land. COA promised to help AVRDC change needed land back to Agriculture R&D Land, if AVRDC needs more land in the future. The process was completed in 8 months before mid-September 2012 to avoid next year's high tax payment.

**THE OFFICE OF THE DEPUTY DIRECTOR GENERAL - ADMINISTRATION & SERVICES MANAGES THE 117-HECTARE HEADQUARTERS CAMPUS.**



### RISK MANAGEMENT

A surprise fire drill was conducted at HQ on 18 October 2012. The Shanhua Fire Brigade provided demonstration and hands-on practice. Eight sets of linked fire alarm systems were installed at headquarters (Security Guard, Administration Building, Lab Building, Food & Dormitory Services, GRSU, New Green House, Old Green House and Service Building).

### HOST COUNTRY RELATIONS

Visits of VIPs from the host government:

- High-ranking officers from Taiwan Agricultural Research Institute (TARI) in February
- ROC visiting group led by COA Vice Minister in May
- Minister without Portfolio Yang Chiu-hsing in July

Events held at the host country's request:

- 2012 Open Day
- Visits of Directors General from international agricultural research centers to AVRDC and Taiwan

The following information and/or documents are frequently requested by COA, MOFA, Legislative Yuan, Control Yuan, National Audit Office, and Directorate-General for Budget, Accounting and Statistics:

- AVRDC's achievements and impacts
- AVRDC's contributions to Taiwan

- Workshops/symposia/conferences held and to be held
- Financial reports
- Staffing

To justify for core contribution, required documents are:

- Achievements of current year: (1) *Technical report*: Achievements of the year and the impacts attained (2) *Financial report*: Analysis of the annual financial statement vs. annual financial planning.
- Work Plan for next year: (1) Major activities and expected impacts (with special emphasis on those related to Taiwan).
- Financial planning

COA initiated a special project to strengthen bilateral cooperation between AVRDC and the host country with a budget size about NT\$10 to 15 million (ca. US\$500,000). A project proposal on research subjects of mutual interest to AVRDC and Taiwan has been developed through consultation between AVRDC and will be submitted to Council of Agriculture.

### MOFA PROJECT SUPPORT

A project proposal entitled "Networking to Enhance International Cooperation in Vegetable Research and Development" was submitted on 12 Dec. 2011 and approved on 17 May 2012 containing three subprojects:

- Subproject 1: Linkages with the international agricultural research centers;

- Subproject 2: ASEAN-AVRDC Regional Network (AARNET);
- Subproject 3: Vegetable Network for Oceania.

Total budget approved is US\$783,300. First installment was released on 17 May 2012. First technical report and financial report were submitted on 26 October 2012 for the period of 1 January to 30 September 2012. Release of second installment depends on review results of the reports.

Supported by Subproject 1, the top leaders from four international agricultural research centers were invited to visit the Center and Taiwan:

- Dr. Trevor Nicholls, Chief Executive Officer, CAB International (27-31 August 2012)
- Dr. Emile Frison, Director General, Bioversity International (8-12 September 2012)
- Dr. Stephen Hall, Director General, WorldFish Center (24-27 September 2012)
- Dr. Jimmy Smith, Director General, International Livestock Research Institute (19-23 November 2012)

ROC funding support is significant to the Center as it pays for staff salaries, ensures continuity of the Center's basic activities, provides opportunities to collaborate with Taiwan's agricultural community, and provides opportunities to enhance partnership with the international agricultural community. ♦

## Financial Services

The Center continues to pursue efforts to improve its financial health and long-term stability. The “full cost recovery” approach for accounting for all costs (direct and indirect) of the Center’s research and development activities, and ensuring they are paid in full by the respective projects are showing impact in the financial results. The Financial Services fulfills the Center’s financial objective by:

- identifying and quantifying costs
- ensuring all costs are properly reflected in the budgets of project proposals
- monitoring full recovery of all project costs

This helps the donors to know the actual costs of their project investments, makes the support and service groups more efficient and able to improve over time, enables the management to conserve and deploy core funds for strategic and non-project funded activities, and contributes to a balanced budget.

As more and more costs are recovered from projects including the institutional services provided by AVRDC, the costs to core for staff, supplies, travel and capital are coming down.

Most financial systems and processes have been streamlined and adhered to at headquarters and in the regions. A large part of the system-based control and

monitoring is now done through Maconomy, the Center’s enterprise resource planning system. Besides the financial staff, the line and project management staff members are familiar with these processes and use them with ease to manage their activities and projects more efficiently.

These systems and processes also assist in prudent financial management, including better expense control, payables and receivables, exchange rate gains/losses, accounting of assets, and bank reconciliations. As a result, activities such as monthly closing, accurate and timely reporting to the donors, cash management, fund transfers to partners and payment to vendors are now executed more efficiently. ♦

## Internal Audit

The internal audit function is to assist AVRDC – The World Vegetable Center to maintain good governance mechanisms to safeguard donors’ interests and strengthen staff members’ compliance with the Center’s regulations. Internal audit tasks include reviewing the Center’s current regulations, making suggestions to amend Standard Operating Procedures where necessary, and auditing regional office operations and the Center’s internal operations and functions.

In 2012, Internal Audit audited the information technology function at headquarters, property

management at headquarters, technical services - farm operations, and the Regional Center for Africa (RCA). Internal Audit participated in the review of the claim for the malfunctioning air conditioner units installed in the headquarters laboratory building.

In the audit of property management at the Center’s headquarters, Internal Audit found that there are improvements that can be made to safeguard the Center’s property. Property obtained other than through the formal procurement process is not included, although current regulations need to be supplemented to reinforce current practices. Another issue related to property management found during the audit of RCA operations was that incorrect data had been uploaded into the Center’s databases. Maintaining good property control mechanisms is a difficult and tedious task, and even experienced staff can make mistakes. In the case of RCA, this was due to personnel turnover in recent years.

In the audit of technical services - farm operations, Internal Audit found that staff was not checking raw data before it was entered into the working database. This was highlighted for correction, to mitigate the use of incorrect data for subsequent tasks. ♦

## Human Resources

For AVRDC staff, the year 2012 ended with a sense of accomplishment and fulfillment. The spirit of caring, fellowship and commitment to the purpose of the Center among us is the driving force in overcoming challenges.

To ensure the Center is well equipped with competencies and staff is highly motivated and engaged, Human Resources focused on building competencies through strategic recruitment and enabled engagement through effective communications, training and strengthening work processes.

On the recruitment front, the Center was successful in attracting good talent, had people on board in time for most positions, and replaced most of the lost talent in Africa and headquarters.

The Center was also successful in adding new competencies with a focus on investing for the present and the future, using a mix of core and project funding. Based on the comprehensive competency analysis done earlier, certain competency gaps have been identified. From this, three priority and strategic competency sets were targeted during the year. They are

- Postharvest leadership and functional competencies
- Data management, monitoring & impact evaluation competencies
- Germplasm, breeding and socioeconomics competencies for the Regional Center for Africa



COLLEAGUES ENJOYED THE FOOD AND CAMARADERIE AT THE CENTER'S YEAR-END CELEBRATION PARTY.

Staff for seven international positions and complementary national positions were recruited. The new staff members have started to address the Center's needs in postharvest, monitoring and evaluation, and data management.

While there are adequate people management systems and processes in the Center, measures were implemented in 2012 to engage staff more fully and enable them to feel proud of their contribution to the Center's goals and mission.

To strengthen communication and awareness about Center's mission and activities among staff members, "Line-of-Sight" training events were organized at headquarters and in East and Southeast Asia. Participating staff explored the meaning and relevance of their job activities/contributions to the goals and mission of the Center. They

also shared work experiences and developed cross-functional team-working skills.

The Role & Leadership workshop for the combined group of management, theme, and regional leaders held during the Strategic Planning week explored aspects of role clarity, building peer-level communication and collaboration, prioritizing among strategic, routine, crisis and development issues, and overall team development.

The performance planning and review process was further strengthened and extended to supervisory grades of nationally recruited staff. For internationally recruited staff, the contract/salary review process is now linked to performance review outcomes.

Staff optimization through needs

analysis and cross deployment is an ongoing activity and action during 2012 helped to reduce costs.

The Center continues its trend of having a good degree of diversity in its staffing. To sustain and improve this trend, as well as harness the diverse perspectives for developing creative solutions, a Diversity and Inclusion policy was implemented. Diversity-positive recruitment guidelines were developed for staff participating in recruitment panels.

The staff eagerly looks forward for another successful year for the Center and personal accomplishments, and the mood during the year-end celebrations shows it! ♦

## Communications and Information

The eight members of the Communications and Information group (secretary, photographer, graphic designer, visitor services coordinator, three librarians, and a group head/editor) aim to influence public perceptions of the Center through the creation of media strategies and promotional materials.

To foster public awareness, the group sends out news releases to local and international media, handles press queries, and develops success stories for donors. Communications and Information published 18 issues of *Fresh*, the AVRDC newsletter,



### A FRESH NEW LOOK FOR WWW.AVRDC.ORG

distributed to more than 3000 subscribers (a 20% increase since 2011); prepared promotional brochures and posters, videos, and PowerPoint presentations; and produced extension publications on various aspects of vegetable production. International press coverage about the Center in 2012 included television programs aired on Agropolitan TV in Indonesia and TV 5, France; reports on global aggregator websites SciDev Net, Huffington Post, Nourishing the Planet, and IRIN; and articles published in *Reader's Digest* (UK and India editions), *Forbes*, and *Appropriate Technology* magazines.

In June 2012 Communications and Information launched the Center's new website (avrdc.org), featuring a streamlined graphic interface, a redesigned search function for publications, video access, online ordering for seed, and more. The site is receiving approximately 30,000 visits each month since the re-launch. Websites also were prepared for the ASEAN-AVRDC Regional Network for Vegetable Research (avrdc.org/

seaveg2014.com). The Communications group coordinates social media outreach through Facebook pages in English and Chinese (www.facebook.com/WorldVegetableCenter), Twitter (@go\_vegetables), and a YouTube channel (www.youtube.com/WorldVegetableCenter). Half of the Center's tweets were re-tweeted by others in 2012.

The Center's editor reviewed more than 200 articles, abstracts, books, proposals, newsletters and other documents in 2012 for grammar, style and coherence. Publications produced during the year included the *Annual Report 2011*, *Year in Review 2011*, *Medium-term Plan 2012-2014*, *Proceedings of the 2012 APSA Workshop*, and translations of several crop production manuals.

Communications coordinated Open Day 2012, held on May 18, which drew more than 60 visitors from Taiwan universities, research institutes, and seed companies to headquarters. The visitors had a choice of three tours—Breeding, Production & Laboratory, and an Overview—that showcased different aspects of the Center's work. The event aimed to build new and strengthen existing relationships with Taiwan's research community, raise the overall profile of the Center in Taiwan, and give research staff a chance to interact with their host-country peers in an informal, informational setting. Reporters from 10 local and national media attended.

In November, the AVRDC Library

([www.avrdclibrary.org](http://www.avrdclibrary.org)), a major repository of information on vegetable research, introduced a policy of linking preprints and postprints of journal articles published by Center staff in online catalog records to foster free and open access to AVRDC research. The library's collection of .pdfs and e-books continues to expand, providing immediate access to information for researchers worldwide. *Library News*, a regular e-newsletter, keeps staff up-to-date on recent acquisitions and the latest articles published by colleagues.

Center headquarters welcomed 981 visitors in 2012, an 18% increase from the previous year. All visitors received briefings and tours tailored to their specific interests. Luggage straps and 40th Anniversary T-shirts and polo shirts were added to Center's collection of corporate gifts. ♦

### Biometrics

Biometrics ensures the integrity, validity and accuracy of research data generated by Center scientists by making sure that 1) statistically valid experimental plans are in place before experiments are conducted, and 2) the statistical analyses follow sound and valid statistical methods to satisfy the experimental objectives.

Through statistics training courses Biometrics contributed to improving and enhancing the skills of AVRDC research staff and project collaborators. The

Center's Biometrician served as a resource person in planning and project workshops, and in AVRDC's International Vegetable Training Course in Thailand.

An important role of Biometrics is to review, edit, comment and provide advice to improve annual/projects reports, proposals, abstracts and papers before submission in peer-reviewed journals. The Biometrician often is a co-author or noted as a statistical expert in scientific papers published by Center authors, including the article "Projecting annual temperature air changes to 2025 and beyond: Implications for vegetable horticulture worldwide," published in the *Journal of Agricultural Science, Cambridge University Press*. Biometrics answers statistical questions or issues raised by reviewers on scientific papers submitted by AVRDC scientists for publication.

Biometrics provided AVRDC scientists with easy access to information on newly released varieties of various crops through the database of variety releases which it maintains. ♦

## Information Technology Services

### BACKUP SYSTEM FOR DATA RECOVERY

The backup server backs up users' data automatically. The server currently stores 1.2 million files from more than 120 personal computers, using approximately two terabytes of storage.

### NEW GROUP STORAGE AT HEADQUARTERS

A high-availability clustered storage system has been implemented at headquarters to meet user and group/team storage requirements.

### OFFSITE BACKUP

Offsite weekly backup to the Amazon S3 cloud is done for databases including the Maconomy ERP system, the payroll system, Agrobases, the Library website, and the GRSU database. The current utilized storage is close to 100 GB.

### WIFI NETWORK SYSTEM

Information Technology Services installed two service identification points to provide internet access to visitors at headquarters and to users of Apple iOS smart devices.

### EMAIL ACCOUNT MAINTENANCE

Information Technology Services maintains the Center's [worldveg.org](http://worldveg.org) Google mail accounts, supporting 208 email accounts for staff in headquarters and at regional offices. ♦



## Global Technology Dissemination

The Global Technology Dissemination group conducted a range of activities in 2012 in technology dissemination, capacity building and agricultural development.

Global Technology Dissemination led or supported a number of activities in AVRDC projects in Indonesia, Bangladesh and India. The group led a research and development project in Indonesia during the year, which included grafting training workshops with 99 participants, school gardens, a value chain study, and on-farm research trials focusing on balanced fertilization, testing AVRDC-improved tomato and pepper lines, and postharvest technologies. In addition, grafting training workshops were conducted in Qatar (20 participants) and the United Arab Emirates (21 participants). Global Technology Dissemination also provided training in tomato grafting for 34 participants at a Training of Trainers for AVRDC's research and development project in Bangladesh. One hundred new summer tomato farmers in Bangladesh successfully applied the technologies they learned from AVRDC training activities and were able to sell their produce.

In collaboration with the breeding and communications groups, Global Technology Dissemination maintained a web-based seed catalog which greatly facilitates germplasm transfer; leafy brassicas were added to the catalog in 2012.



Global Technology Dissemination managed the Demonstration Garden at headquarters, which showcases the Center's technologies to visitors and trainees, including 70-90 crop species or varieties year-round. Nutritional and other information about each crop can be found on signs that are constantly updated. Staff provided tours of the Garden to 831 visitors from 46 countries in 2012.

Global Technology Dissemination published *Feedback from the Field*, a quarterly bulletin that communicates technology applications and urgent issues from the field to its readers. This publication is disseminated via the AVRDC website, email and Facebook. The group also coordinated the Center's Disaster Response Program, which distributes seed of hardy, fast-growing and nutritious vegetable crops to disaster survivors. Global Technology Dissemination coordinated the Center's exhibits at Taiwan's annual "Seed and Seedling Festival and Exhibition of Agricultural Achievements."

**EASY-TO-FOLLOW INSTRUCTIONAL VIDEOS INTRODUCED THE CENTER'S VEGETABLE GRAFTING TECHNOLOGY TO A WIDER AUDIENCE.**

Global Technology Dissemination played a vital role in leading and contributing to project proposals and concept notes, especially on development-oriented aspects. The group managed the Center's mature technologies database and training documents on the intranet to facilitate use by AVRDC staff. Global Technology Dissemination wrote planting instructions for 15 crops to support the AARNET project and these are posted on the AVRDC website. Videos on how to graft tomatoes and cucurbits were filmed and posted on the website and YouTube to enable technology adoption by end users.

Global Technology Dissemination is formulating a recommended



process for AVRDC’s development projects.

The group facilitated administrative issues and logistics for 45 trainees at headquarters for capacity building activities across a range of disciplines.

Global Technology Dissemination is coordinating a group of 34 AVRDC scientists worldwide who work on technology dissemination and capacity building, to provide a more unified and coherent effort to create outcomes and impacts. Global Technology Dissemination gathered data worldwide for the

Center’s accomplishments in capacity building and technology dissemination. ♦

**AVRDC STAFF IN MALI PROMOTED VEGETABLE PRODUCTION AND CONSUMPTION AT FAIRS, FIELD DAYS, AND WORKSHOPS, AND INTRODUCED FARMERS TO NEW METHODS OF PREPARING VEGETABLE JUICES, SAUCES, AND DRIED PRODUCTS.**

## Grants & Partnership Development

The overall goal for Grants & Partnership Development is to be an effective and efficient institutional support function for the research and development agenda of AVRDC in terms of resource mobilisation and project management/administration. This is realized mainly through quality review, facilitation and coordination and in doing so acting as a focal point for grants (proposals and projects) and partnership development at the Center.

Grants & Partnership Development consists of two staff (a manager and an assistant) and its work is mainly in three areas:

- (i) Facilitate, coordinate and support resource mobilisation efforts: donor intelligence and priorities; review, edit and submission of concept notes and proposals; development of partnerships.
- (ii) Monitor and support project management/administration: negotiate, draft, review and edit agreements; review, edit and submission of reports; a multitude of other project specific issues.
- (iii) Development and management of tools for resource mobilisation and project management/administration.

The institutional processes and procedures for resource mobilisation and project management/administration laid

down in late 2010 have been fully implemented, hence proposals and projects now follow the review/quality control process. Special efforts were made during the year to substantially contribute to a better understanding within the Center of 'why and how' full cost recovery is needed from projects, as well as ensuring it as much as is possible, given circumstances, incorporated into each proposal.

The Office of the Deputy Director General for Research is the oversight office for the Center's research and development agenda and so it is crucial that the office receives relevant information in a systematic manner. Grants & Partnership Development have in 2012 continued to manage this process.

Maconomy, the Center's enterprise resource planning system, has been populated with the Center's concept notes/proposals, project data and agreements. The system has been improved to better support the resource mobilisation process as well project management/administration. For risk management purposes a generic archiving system that can be easily navigated has been created.

During the year 62 concept notes and proposals were reviewed, edited and submitted to a multitude of donors; 79 technical project reports to donors and partners were reviewed, edited and submitted.

All agreements that the Center signs with donors and partners (currently the Center collaborates

with more than 170 partners across the globe) passes through Grants & Partnership Development which has, during the year, supported negotiations, prepared, reviewed (legal) and edited numerous agreements. ♦

## Introducing AIRCA

The **Association of International Research and Development Centers for Agriculture (AIRCA)** was formalized in March 2012 at a meeting at FAO, Rome and launched at the GCARD 2 meeting in Punta del Este, Uruguay in October 2012 to make a vigorous, combined impact on the attainment of the Millennium Development Goals to eliminate global poverty and malnutrition. The nine research and development centers in the partnership include AVRDC, CABI, Tropical Agriculture Research and Higher Education Center (CATIE), Crops for the Future (CFF), International Center for Biosaline Agriculture (ICBA), the International Center for Integrated Mountain Development (ICIMOD), Africa Insect Science for Food and Health (icipe), IFDC, and the International Network for Bamboo and Rattan (INBAR).

When acting together, these institutions have substantive global reach through their well-developed networks of country partners in the Americas, Africa and the Asia-Pacific Region. They have particular strengths in helping countries in the developing world build their own research and development capacity to address agricultural and health related issues. All have an established, historical track record of successful research outcomes that have been scaled up to development impact at landscape and regional levels.

AIRCA's expertise compliments that of FAO and the CGIAR, as well as national programs with respect to staple crops. AIRCA members add further competence in crops with high economic, social, nutritional and ecological value. They have long experience in helping farmers overcome the difficulties they

experience at field level in troublesome niche environments and can provide supporting germplasm and diagnostic skills in the front line trenches in the battle against environmental and biological forces which poor farmers face on a daily basis.



Linkage with strong regional networks ensures AIRCA members have the capacity necessary to plan, develop and execute scientific endeavors with strong local support and a high probability of attaining sustainable development outcomes. These local networks are further complimented by their relative diversity, as the AIRCA's specific expertise is attractive to both public and private sector actors within the development community.

Being strongly oriented towards problem solving at a systems, rather than at a single commodity, level helps the research and development actions of AIRCA members be better grounded in the day-to-day problems experienced and articulated by poor farming communities in the developing world. Addressing complex and rapidly evolving problems such as global climatic uncertainty and widespread malnutrition can be done in a confident manner as AIRCA is supported by world-scale high-quality knowledge and germplasm banks, from which material is made available to partners as freely and effectively as possible. Thus, the design of realistic climate-smart landscapes is an achievable output which will substantively contribute

to the intensified, sustainable development outcome presently sought by the global community.

The demonstrated ability to respond quickly and efficiently to agricultural problems, relatively small size and uncomplicated governance and management structures of AIRCA's members enables them to combine and re-combine simply and as necessary with a wide diversity of partners, and to offer alternative types of expertise required to provide solutions to development problems. Working relationships with other major players such as FAO, the CGIAR Centers, the academic community and the private sector worldwide are in place and are used as required. AIRCA recognizes that we are all players on the same team and that each can contribute expertise as and where necessary in the services of assisting the poor and disadvantaged.

Addressing the ever-present global dangers of flooding, drought, salinity, soil infertility, pests and diseases and their consequent agricultural impact on human diets, health and prosperity is AIRCA's call to action. All AIRCA members seek to contribute to a world in which the Millennium Development Goals can be made redundant as quickly as possible and they pledge their renewed efforts with donors and partners to actively support this desired state. ♦

# WHO WE ARE

*In 2012, AVRDC - The World Vegetable staff members came from 28 countries, including Taiwan. Women occupy 30% of the 57 senior staff positions.*



Name	Position	Location	Nationality
Afari-Sefa, Victor	Scientist – Socioeconomics and Global Theme Leader, Consumption	Arusha, Tanzania	Ghana
Ahmad, Shahabuddin	Vegetable Sector Leader (Bangladesh)	Dhaka, Bangladesh	Bangladesh
Belarmino, Marilyn	Scientist – Genetic Resources (left June 2012)	Arusha, Tanzania	Philippines
Bhattarai, Madhusudan	Agricultural Economist (left April 2012)	Shanhua, Taiwan	Nepal
Chagomoka, Takemore	Liaison Officer for Cameroon and Seed Business Specialist	Yaoundé, Cameroon	Zimbabwe
Chang, Jan	Postdoctoral Fellow, Molecular Entomology	Shanhua, Taiwan	Taiwan
Chang, Yin-Fu	Deputy Director General – Administration & Services	Shanhua, Taiwan	Taiwan
Chen, Hwei-mei	Associate Specialist, Biotechnology/Molecular Breeding	Shanhua, Taiwan	Taiwan
Chen, Willie	Assistant Specialist, Global Technology Dissemination	Shanhua, Taiwan	Taiwan
Cho, Myeong-Cheoul	Scientist – Pepper Breeding	Shanhua, Taiwan	Korea
Dhillon, Narinder	Vegetable Breeder, Cucurbits	Bangkok, Thailand	India
Dinssa, Fekadu Fufa	Vegetable Breeder	Arusha, Tanzania	Ethiopia
Easdown, Warwick	Regional Director, South Asia	Hyderabad, India	Australia
Ebert, Andreas	Genebank Manager and Global Theme Leader, Germplasm	Shanhua, Taiwan	Germany
Endres, Theresa	Community Development Specialist (Nutrition)	Bamako, Mali	Germany
Ghai, Tilakraj	Consultant	Punjab, India	India
Gniffke, Paul	Plant Breeder – (retired June 2012)	Shanhua, Taiwan	USA
Habicht, Sandra	Postdoctoral Fellow, Biochemical Nutrition	Shanhua, Taiwan	Germany
Hanson, Peter	Plant Breeder (Tomato and Indigenous Vegetable Research) and Global Theme Leader, Breeding	Shanhua, Taiwan	USA
Holmer, Robert	Regional Director, East and Southeast Asia	Bangkok, Thailand	Germany
Hsu, Sylvia	Manager, Food and Dormitory Services	Shanhua, Taiwan	Taiwan
Hughes, Jacqueline d'Arros	Deputy Director General - Research	Shanhua, Taiwan	United Kingdom
Inukonda, Nagaraj	Director of Human Resources	Shanhua, Taiwan	India
Keatinge, J.D.H.	Director General	Shanhua, Taiwan	Ireland
Kenyon, Lawrence	Plant Virologist	Shanhua, Taiwan	United Kingdom

## STAFF

Name	Position	Location	Nationality
Krishnan, Bharath	Manager – Information Technology Services	Shanhua, Taiwan	India
Kumar, Sanjeet	Vegetable Breeder	Shanhua, Taiwan	India
Kwazi, Nadine	Executive Assistant to the Director, Regional Center for Africa	Arusha, Tanzania	Zambia
Ledesma, Dolores R.	Board Secretary and Biometrician	Shanhua, Taiwan	Philippines
Lee, Jung-Sup	Plant Pathologist (left January 2012)	Shanhua, Taiwan	Korea
Lin, Chih-hung	Associate Specialist, Bacteriology	Shanhua, Taiwan	Taiwan
Lu, Vincent	Internal Auditor	Shanhua, Taiwan	Taiwan
Luther, Greg	Technology Dissemination Specialist	Shanhua, Taiwan	USA
Luther, Kartini	Assistant to Deputy Director General-Research	Shanhua, Taiwan	USA
Ma, Chin-hua	Associate Specialist, Bacteriology	Shanhua, Taiwan	Taiwan
Mak, Adrienne	Manager, Management Support & Human Resources Services	Shanhua, Taiwan	Taiwan
Manickam, Ravishankar	Research Site Coordinator	Jharkhand, India	India
Maryiono, Joko	Project Site Coordinator (Indonesia)	Jawa Timur, Indonesia	Indonesia
Mavlyanova, Ravza	Regional Coordinator for Central Asia and the Caucasus	Tashkent, Uzbekistan	Uzbekistan
Mecozzi, Maureen	Head, Communications and Information	Shanhua, Taiwan	USA
Moustafa, Ahmed	Regional Director, Central & West Asia and North Africa (left May 2012)	Dubai, UAE	Egypt
Nair, Ramakrishnan	Vegetable Breeder, Legumes	Hyderabad, India	India
Ndung'u, Philip Kamau	Regional Administration and Finance Officer (left December 2012)	Arusha, Tanzania	Kenya
Neave, Suzanne	Project Coordinator, Solomon Islands (left November 2012)	Honiara, Solomon Islands	United Kingdom
Nenguwo, Ngoni	Postharvest Specialist	Arusha, Tanzania	Zimbabwe
Öberg, Annelie	Manager, Grants and Partnership Development	Shanhua, Taiwan	Sweden
Ojiewo, Christopher	Vegetable Breeder (left October 2012)	Arusha, Tanzania	Kenya
Olatifede, Kolade	Director of Finance	Shanhua, Taiwan	Nigeria
Ramasamy, Srinivasan	Entomologist	Shanhua, Taiwan	India
Rouamba, Albert	Vegetable (Onion) Breeder	Bamako, Mali	Burkina Faso
Schafleitner, Roland	Head, Molecular Genetics	Shanhua, Taiwan	Austria
Schreinemachers, Pepijn	Agricultural Economist	Shanhua, Taiwan	The Netherlands
Tenkouano, Abdou	Regional Director, Africa	Arusha, Tanzania	Burkina Faso
Tsai, Wen-shi	Associate Specialist, Virology	Shanhua, Taiwan	Taiwan
Wang, Jaw-fen	Plant Pathologist and Global Theme Leader, Production	Shanhua, Taiwan	Taiwan
Wang, Peter	Technical Services Superintendent (left June 2012)	Shanhua, Taiwan	Taiwan
Yang, Ray-yu	Nutritionist	Shanhua, Taiwan	Taiwan



# RESEARCH for DEVELOPMENT

◆ 27

Number of scientists

◆ 2.48

Externally reviewed publications per scientist  
(journal articles, books, book chapters)

◆ 1.11

Publications per scientist in journals  
listed with Thomson Reuters ISI

◆ 63%

Percentage of scientific papers in  
refereed journals and books published  
with partners from developing countries



## TOP 10 JOURNALS

The top 10 journals Center (as rated by Thomson Scientific/ISI impact factors) in which Center researchers published during 2012:

- *Transgenic Research* (2.754)
- *Journal of Microbiological Methods* (2.544)
- *Plant Disease* (2.449)
- *Journal of Agronomy & Crop Science* (2.433)
- *Food Policy* (2.432)
- *Plant Pathology* (2.125)
- *European Journal of Plant Pathology* (2.054)
- *Food Security* (1.970)
- *Euphytica* (1.554)
- *Genetic Resources & Crop Evolution* (1.554)



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# FINANCIAL HEALTH



**MADEIRA VINE (ANREDERA CORDIFOLIA), AN INDIGENOUS VEGETABLE IN EAST ASIA, THE CARRIBEAN, AND THE TROPICAL AMERICAS, IS ONE OF THE DOZENS OF VEGETABLES GROWING IN THE AVRDC DEMONSTRATION GARDEN. SOUND FINANCIAL MANAGEMENT SUPPORTS THE GARDEN AND ALL OF THE CENTER'S GLOBAL ACTIVITIES.**

*The Center's strong long-term financial support from its host country, Taiwan, helps to compensate for Taiwan's relatively high labor costs.*

*Unrestricted revenues in 2012 comprised 67% of the total (US\$ 13.2 million) and were obtained from national governments; restricted revenues made up 33%.*



	AVRDC	CGIAR **RECOMMENDED RANGE
<b>CASH MANAGEMENT ON RESTRICTED OPERATIONS *</b>	0.1	LESS THAN 1
<b>ADEQUACY OF RESERVES</b>	117 DAYS	75-90 DAYS
<b>SHORT-TERM SOLVENCY</b>	184 DAYS	90-120 DAYS

\* Restricted accounts receivable divided by restricted accounts payable expressed as a ratio

\*\* Consultative Group on International Agricultural Research





## 2012 Revenues (in '000 USD)

Unrestricted grants	8,733	66%
Restricted grants	4,313	33%
Other revenues	199	1%
<b>Total</b>	<b>13,245</b>	<b>100%</b>

<b>Unrestricted Grants</b>		
Republic of China (ROC)	5,301	
UK Department for International Development (UK/DFID)	1,721	
United States Agency for International Development (USAID)	1,157	
Thailand	151	
Asia and Pacific Seed Association (APSA)	150	
Germany	122	
Korea	50	
Philippines	50	
Japan	30	
<b>Sub-total</b>	<b>8,733</b>	
Other revenues	199	
<b>Total</b>	<b>8,931</b>	

<b>Restricted Grants</b>		
United States Agency for International Development (USAID)	1,599	
Republic of Germany / BMZ / GIZ	1,053	
Australian Centre for International Agricultural Research (ACIAR)	305	
Republic of China / Ministry of Foreign Affairs	219	
Republic of China / National Science Council	188	
Swiss Development Cooperation (SDC)	164	
Sir Ratan Tata Trust Foundation	156	
Republic of China / Council of Agriculture	150	
Korea / Rural Development Administration (RDA)	122	
Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)	34	
Australian Government Overseas Aid Program (AusAID)	33	
Kagome Co., Ltd.	18	
European Union	18	
Global Crop Diversity Trust	16	
Known-You Seed Co., Ltd.	12	
Japan	8	
Volkswagen / University of Freiburg	7	
Others	211	
<b>Sub-total</b>	<b>4,313</b>	
<b>Total Revenues</b>	<b>13,245</b>	

# ACRONYMS & ABBREVIATIONS

<b>AARNET</b>	ASEAN-AVRDC Regional Network
<b>ACIAR</b>	Australian Centre for International Agricultural Research
<b>ADFCA</b>	Abu Dhabi Food Control Authority
<b>AIRCA</b>	Association of International Research and Development Centers for Agriculture
<b>ASEAN</b>	Association of Southeast Asian Nations
<b>AVGRIS</b>	AVRDC Vegetable Genetic Resources Information System
<b>BYVMV</b>	<i>Bhendhi yellow vein mosaic virus</i>
<b>CaCV</b>	<i>Capsicum chlorosis virus</i>
<b>CAPSA</b>	Centre for Alleviation of Poverty through Sustainable Agriculture
<b>CATIE</b>	Tropical Agriculture Research and Higher Education Center
<b>CFF</b>	Crops for the Future
<b>CGIAR</b>	Consultative Group on International Agricultural Research
<b>CIP</b>	International Potato Center
<b>CMS</b>	Cytoplasmic male sterility
<b>COA</b>	Taiwan Council of Agriculture
<b>CRS</b>	Catholic Relief Services
<b>CWANA</b>	Central & West Asia and North Africa
<b>DAAD</b>	German Academic Exchange Service
<b>ERP</b>	Enterprise resource planning system
<b>FAO</b>	Food and Agriculture Organisation of the United Nations
<b>FSC</b>	Food Security Center, University of Hohenheim, Germany
<b>GAA</b>	Germplasm Acquisition Agreement
<b>GIZ</b>	Gesellschaft für Internationale Zusammenarbeit
<b>GRSU</b>	Genetic Resources and Seed Unit
<b>GTD</b>	Global Technology Dissemination
<b>HortCRSP</b>	USAID Horticulture Collaborative Research Support Program
<b>ICARDA</b>	International Center for Agricultural Research in the Dry Areas
<b>ICBA</b>	International Center for Biosaline Agriculture
<b>ICIMOD</b>	International Center for Integrated Mountain Development
<b>icipe</b>	Africa Insect Science for Food and Health
<b>ICIS</b>	International Crop Information System
<b>ICRISAT</b>	International Crops Research Institute for the Semi-Arid Tropics
<b>IFAD</b>	International Fund for Agricultural Development
<b>IITA</b>	International Institute for Tropical Agriculture
<b>INBAR</b>	International Network for Bamboo and Rattan
<b>ITS</b>	Internal transcribed spacer
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>IVTC</b>	International Vegetable Training Course
<b>JIRCAS</b>	Japan International Research Center for Agricultural Sciences
<b>KGKV</b>	Krishi Gram Vikas Kendra
<b>KU</b>	Kasetsart University, Thailand
<b>LC-MS</b>	Liquid chromatography – mass spectrometry
<b>MAS</b>	Marker-assisted selection
<b>MGD</b>	Millennium Development Goals

<b>MOFA</b>	Taiwan Ministry of Foreign Affairs
<b>MTA</b>	Material Transfer Agreement
<b>MYMV</b>	<i>Mungbean yellow mosaic virus</i>
<b>NARES</b>	National agricultural research and extension systems
<b>PADFA</b>	Projet D'appui Au Developement Des Filières Agricoles
<b>PCR</b>	Polymerase chain reaction
<b>PVMV</b>	<i>Pepper veinal mottle virus</i>
<b>QTL</b>	Quantitative trait loci
<b>RCA</b>	Regional Center for Africa
<b>RIL</b>	Recombinant inbred line
<b>RNAi</b>	RNA interference
<b>SDC</b>	Swiss Development Corporation
<b>SMTA</b>	Standard Material Transfer Agreement
<b>SqLCPHV</b>	<i>Squash leaf curl Philippine virus - Taiwan isolate</i>
<b>SRTT</b>	Sir Ratan Tata Trust
<b>SSR</b>	Simple sequence repeats
<b>TSWV</b>	<i>Tomato spotted wilt virus</i>
<b>TYLCV</b>	<i>Tomato yellow leaf curl virus</i>
<b>ToLCTWV</b>	<i>Tomato yellow leaf curl Taiwan virus</i>
<b>TYLCTHV</b>	<i>Tomato yellow leaf curl Thailand virus</i>
<b>UAE</b>	United Arab Emirates
<b>UN-ESCAP</b>	Economic and Social Commission for Asia and the Pacific of the United Nations
<b>USAID</b>	United States Agency for International Development
<b>vBSS</b>	Vegetable Breeding and Seed Systems for Poverty Alleviation in sub-Saharan Africa
<b>VEGINET</b>	Vegetable Science International Network
<b>WARDA</b>	Africa Rice Center

