AVRDC
The World Vegetable Center

annual report 2011

NOURISHING THE WORLD

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

AVRDC – The World Vegetable Center

2011 Annual Report

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AVRDC Director General **J.D.H. "Dyno" Keatinge** with **Manju Vishwakarma** (*right*), General Manager, Ankur Seeds and Ankur chili breeder **Divya Ashish**. The Center's resilient, nutritious vegetable lines are used by public agencies and the private sector to develop improved varieties that reach farmers around the world.

Foreword

About 3 billion people in the world are malnourished due to micronutrient malnutrition caused by imbalanced diets or a lack of food.

Those without sufficient food are undernourished and suffer from weakened immune systems, stunted growth, and impaired cognitive development. Those who consume an excess of carbohydrates and oils are overnourished and prone to chronic diseases such as anemia, blindness, cardiovascular disease, diabetes and cancer.

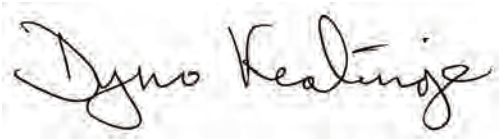
Asia is home to more than 70% of the world's malnourished children; there is a strong association between the mortality rate of children under five and micronutrient malnutrition. In Asia and the Pacific, almost 600 million malnourished people add a considerable burden to already overstretched healthcare systems.

Managing global malnutrition is complex, particularly in light of climate uncertainty and the potential for social unrest. Many nations adopted the United Nations Millennium Declaration in 2000 and agreed to the time-bound targets of the Millennium Development Goals (MDGs), yet progress toward these goals has been uneven. Some countries in Asia (including Vietnam, Nepal, India, Cambodia, Bangladesh and China) have made significant strides, and Thailand and Sri Lanka have made some progress—however, the challenges to improve child and maternal health and eliminate chronic malnutrition remain, with many rural-urban disparities.

AVRDC fosters the attainment of all eight MDGs to the fullest extent possible by advocating for greater fruit and vegetable consumption and properly balanced diets worldwide.

While biofortification, dietary supplements, and other interventions can improve nutrition, the easiest way to enhance the quality of nutritionally deficient diets is for the poor to grow their own nutritious food. Vegetables are a key source of micronutrients to improve the health of the malnourished poor, particularly vulnerable women and children. With locally available, high nutrient content vegetables such as mungbean, kangkong, moringa, sweet potato leaves and bitter gourd, as well as tomato, onion and cabbage, communities can ensure good nutrition through balanced diets and also increase household incomes.

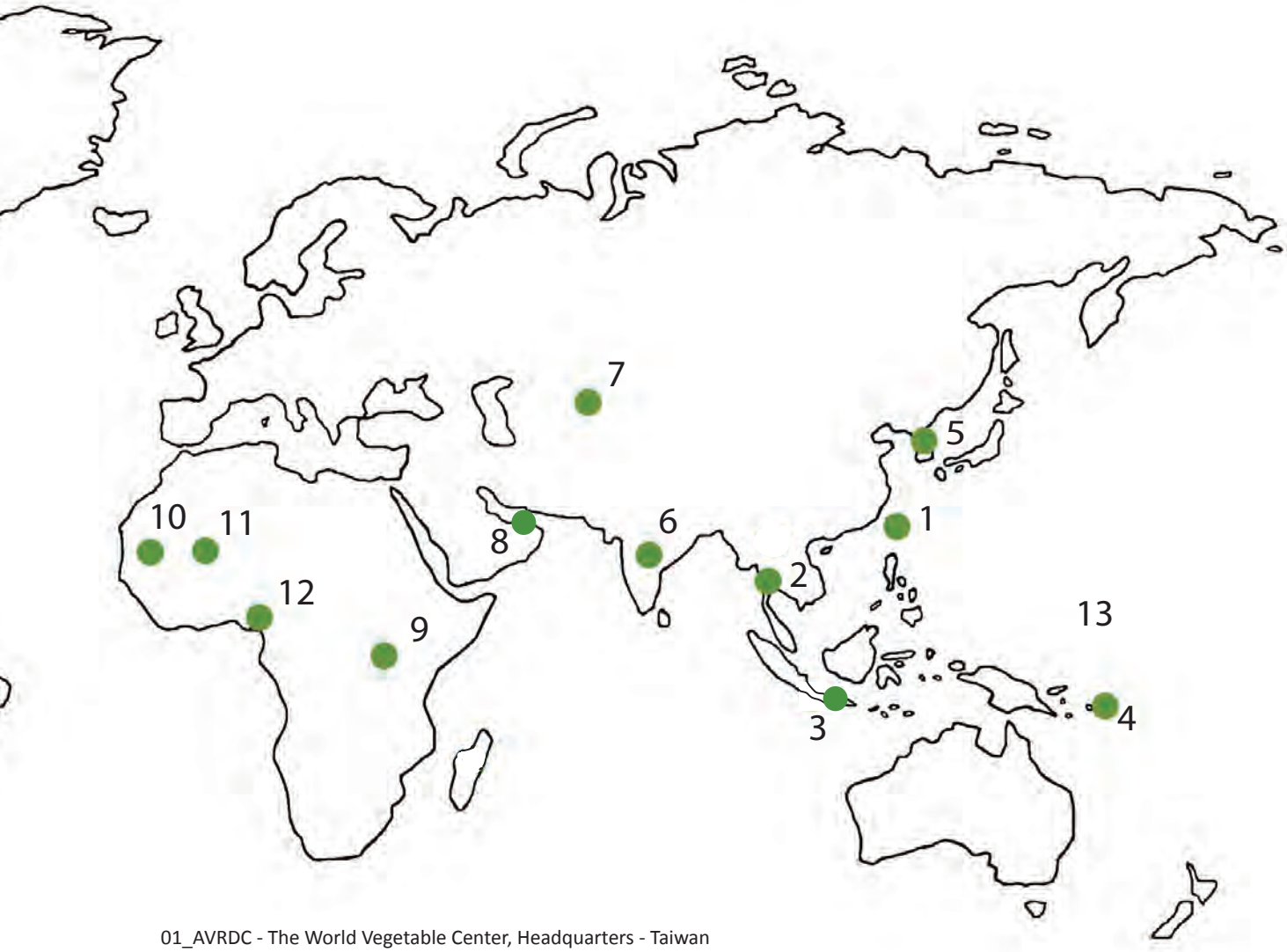
Through our research and development efforts, the Center strives to breed resilient and nutritious vegetable lines, disseminate efficient and safe agronomic management technologies, promote greater postharvest value addition and better storage, marketing, and food preparation methods—all leading to increased consumption of wholesome vegetables.



J.D.H. Keatinge
Director General

WORK AROUND the WORLD

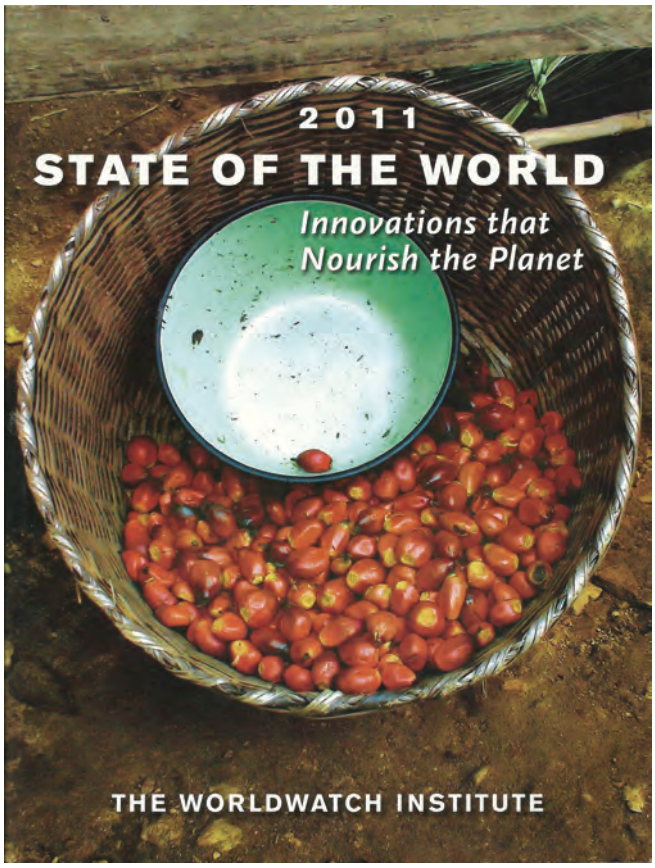
Offices



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 - Honiara, Solomon Islands
05_Korean Sub-Center - Suwon, Republic of Korea
06_South Asia (SA) - Hyderabad, India
07_Office for Central Asia and the Caucasus - Tashkent, Uzbekistan
08_Central and West Asia and North Africa (CWANA) - Dubai, UAE
09_Regional Center for Africa (RCA) - Arusha, Tanzania
10_Sub-regional Office for West and Central Africa - Bamako, Mali
11_Project Office - Niamey, Niger
12_Project Office - Yaoundé, Cameroon
13_Oceania (through Headquarters, Taiwan)

State of the World 2011: Innovations that Nourish the Planet published by the Worldwatch Institute, an influential research and environmental advocacy organization, devoted a full chapter to AVRDC's work to increase the production and consumption of nutritious vegetables in sub-Saharan Africa.

The Center's participatory research activities, promotion of indigenous vegetables for nutrition and market potential, and support for policymakers and partners to develop and strengthen the seed supply chain were noted as positive examples for expansion of the continent's vegetable sector.



Strategic Organization

Founded in 1971, AVRDC – The World Vegetable Center started as the Asian Vegetable Research and Development with a mandate to support vegetable research and development in Asia, focusing more on Southeast Asia. As AVRDC gained expertise and capacity, it began an expansion of its work beyond Asia and in 2008 formally adopted the name AVRDC – The World Vegetable Center to reflect its geographical scope.

The Center's headquarters is located in Shanhua, Taiwan. Currently, the Center is physically present in Asia, Africa and Oceania, with four regional offices in Bangkok, Thailand (for East and Southeast Asia), Arusha, Tanzania and Bamako, Mali (Regional Center for Africa), Hyderabad, India (South Asia) and Dubai, United Arab Emirates (Central and West Asia and North Africa). Additional offices and staff members are located in Bangladesh, Cameroon, Fiji, Indonesia, and Uzbekistan. The Center's work in Oceania is coordinated by headquarters through the Center's office in Fiji.

The Center's research and development activity is structured under four broad themes that work integrally as a matrix with the regional centers and headquarters. The themes represent aspects of the whole vegetable value chain: germplasm collection to conserve biodiversity and ensure seed availability; breeding for improved quality of crops; improved production techniques for higher and better quality yields; promotion of better postharvest management, value addition and marketing; and finally, consumption for better nutrition.

Theme 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.

Theme 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.

Theme 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.

Theme Consumption

Balanced diet through increased access to and utilization of nutritious vegetables

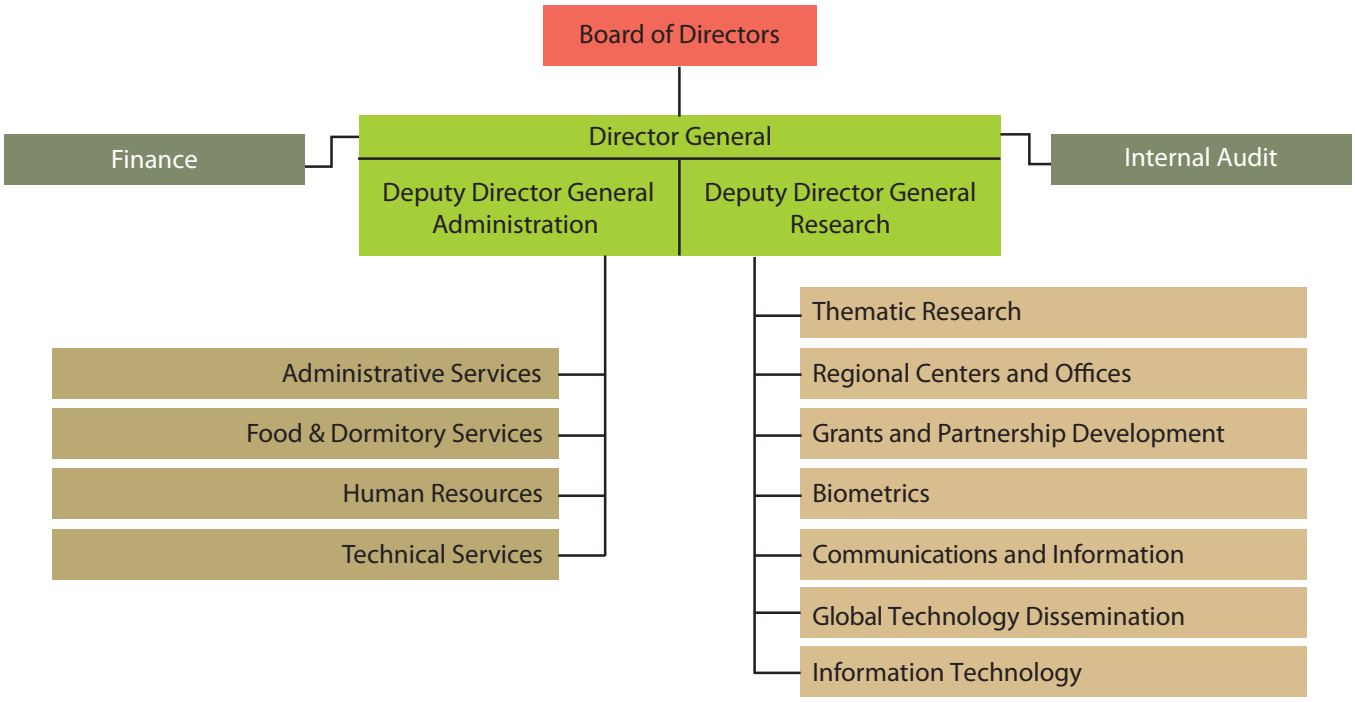
Goal: Consumer health improved by increased consumption of nutritious vegetables for a balanced diet.
Purpose: Increased public awareness, accessibility and utilization of nutritious and diverse vegetables.

Each theme conducts basic and applied research activities. The results are used to formulate development components to generate positive outcomes and impacts as the objective.

Partnering with many public and private sector institutions, the Center's research and development work involves laboratories and greenhouse studies, field trials at multiple locations around the globe, participatory research and development work with national agricultural research and extension systems, the private sector, nongovernmental organizations, women's groups, and farmers' organizations, with a strong focus on capacity building, promotional and advocacy activities. The Center's Global Technology Dissemination group mobilizes AVRDC's research and development to ensure widespread awareness and adoption of improved vegetable technologies. ♦

Structure

The organizational structure of AVRDC – The World Vegetable Center serves the needs of a decentralized institution. Senior management comprises a Director General, a Deputy Director General for Research and a Deputy Director General for Administration and Services. A further level of management consists of a Director of Finance, a Human Resources Director, Global Theme Leaders, and Regional Directors. These senior staff members participate in two institutional committees to address the Center's practical, pertinent elements of conduct: the Institutional Management Committee (chaired by the Director General) and the Institutional Research and Development Committee (chaired by the Deputy Director General – Research).



African eggplant 'DB3' released in Tanzania in February 2011 proved to be popular with farmers and consumers alike. It was one of 86 improved vegetable varieties produced through the Vegetable Breeding and Seed Systems for Poverty Alleviation in sub-Saharan Africa (*vBSS*) project, which ended in May 2011.

Work Around the World

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 2011, the **Regional Center for Africa** (RCA) completed a series of infrastructural upgrades. In Tanzania, an auditorium was constructed and equipped, farm buildings, access roads, and irrigation channels were renovated, and benches were constructed for the laboratory building. Equipment upgrades included a tractor and trailer, farm implements, plough, 16-disc harrow, wheelbarrows, fuel tank, water pumps, boardroom chairs, air conditioning units, and fire extinguishers. A sound system and a simultaneous interpretation system for the newly built auditorium, an interactive whiteboard for the training room, wireless video projection equipment and electronic dropdown screens for the auditorium and the meeting room were acquired. Attempts to sanitize the research farm's sandy soil by controlled flooding and rotation with rice proved challenging as the water holding capacity of the soil was very low and water was lost to infiltration.

In Mali, hosting agreements with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) led to the construction of a new office building, opened in December 2011; three other structures—an onion storage facility and two screen houses—will be ready for use in the first quarter of 2012. Field infrastructure was upgraded with the acquisition of large pollination cages, two refrigerators for seed storage, and drip irrigation equipment. Miscellaneous office furniture and equipment were also purchased, and the vehicle fleet was improved by transfer of a Toyota Prado station wagon from Cameroon.

The Vegetable Breeding and Seed Systems for Poverty Alleviation in sub-Saharan Africa (*vBSS*) project was closed in May 2011, after delivering a total of 86 improved vegetable varieties from 12 crops, representing 60% of the initial 9-year target. The new varieties are at different stages of release in sub-Saharan Africa, with 47 already having been released; about 40% of the varieties are already on the market. The full realization of the benefits of this successful project will materialize in the next 3 to 5 years, when widespread dissemination of the new varieties will have taken place.

Home garden seed kits were distributed via nongovernmental organizations or Farmers' Associations and supported by displays at agricultural fairs in Cameroon (January and November 2011), Tanzania (April and December 2011), Burkina Faso (June 2011) and Mali (May and November 2011). The kits' cropping components and planting sequences need to be fine-tuned, and estimates need to be made of the nutritional yield and health benefits they can provide.

To improve the productivity of vegetables in the Sahel region, low-cost microirrigation techniques were promoted in conjunction with AVRDC improved lines. In Burkina Faso, field demonstrations of solar-powered microirrigation showcased the judicious acquisition and use of water for quality vegetable production. Several irrigation (drip, can, spray and gravity) and soil water conservation (hay mulch, plastic mulch, and "Zaï") systems were demonstrated. Drip irrigation and plastic mulching following seedbed preparation with organic manure resulted in earlier maturity of the tested varieties with more frequent harvests. In Mali, preliminary results showed that improved vegetable lines performed far better than seed of local varieties. Demonstrations carried out in Tanzania with a focus on safe production techniques and a capacity-building objective reached 200 youths in 2011, in support of the Tanzania Agricultural Productivity Program.

Cognizant of the poverty and nutritional demographics imposed by increased urbanization, RCA worked with staple crop international centers on food and nutritional security, focusing on issues pertaining to (i) vegetables as companion crops to staple food crops and (ii) resource use efficiency and safety in urban and peri-urban settings in a

series of project development consultations under the theme of "Sustainable Intensification of Cereal-based Systems" sponsored by the United States Agency for International Development (USAID), with expected interventions in maize-based systems in northern Ghana and Tanzania, sorghum-based systems in southern Mali, and rice-based systems in northern Ghana and Tanzania. ♦

Central & West Asia and North Africa

The regional office for **Central & West Asia and North Africa** (CWANA) is hosted by the International Center for Agricultural Research in the Dry Areas (ICARDA) in Dubai, United Arab Emirates (UAE); the Regional Director is jointly appointed with ICARDA. The sub-regional office is in Tashkent, Uzbekistan with a scientist and a secretary.

In 2011, activities focused on technology dissemination and capacity building. Vegetable lines were tested and released through national partners, and grafting, hydroponics and net houses were demonstrated and used. AVRDC's Regional Varietal Trial of 184 accessions of 13 vegetable species was conducted in eight countries in Central Asia and Caucasus (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan). Twenty-three lines of tomato, sweet and hot pepper, eggplant, cucumber, vegetable soybean, mungbean, yard-long bean and cabbage were under state variety trials in Armenia, Azerbaijan, Kazakhstan, Tajikistan and Uzbekistan. Eight new varieties were released and included in State Registers including tomato 'Narek' and 'Janna', hot pepper 'Kon' and sweet pepper 'Emili' in Armenia; soybean 'Sulton', mungbean 'Durdona', yard-long bean 'Oltin soch' and Chinese leafy cabbage 'Sharq guzali' in Uzbekistan. Seeds of new AVRDC lines were sent to the UAE, Yemen, Oman, Qatar and Bahrain for testing and evaluation. In the Emirates and Qatar, studies on tomato, pepper and okra cultivars were carried out at several private farms, with promising preliminary results.
In Qatar, grafted tomato was planted in the open field at Al Sulaiteen Agriculture and Industrial Complex (SAIC). The yield hit records of 10 kg/m^2 from 3 February - 6 April 2011, substantially higher than Qatar's average open field tomato yield of 3 kg/m^2. In Central Asia and the Caucasus, a study of local tomato varieties and AVRDC rootstocks in greenhouse conditions revealed four promising rootstock lines. Several hydroponic systems were installed on private farms in UAE and Qatar to enhance productivity while reducing capital inputs. Studies include using polyvinyl plastic to form growing canals, which resulted in faster installation at lower cost. Simple hydroponics controllers were introduced to growers. In UAE, yield and water productivity of cucumber in hydroponics increased by 2.3 and 2.6 times, respectively, compared with soil-based systems. Production of vegetable crops with hydroponics in net houses was studied in UAE, where results proved that net houses could be in production for 8-9 months/year. Compared with cooled greenhouses, net houses provide better ventilation, are 60% less costly to run, and are easy and fast to install.

Capacity building activities took place, including a training course on Good Agricultural Practices in Qatar for 23 researchers and extension agents from seven Arabian Peninsula countries. Three seminars and field days on hydroponic production systems for vegetables were organized in the UAE at Ras Al Khaimah, Dhaid, and Fujairah; 90 extension agents and growers participated. Training on the cultivation of new vegetable varieties in Bostanlyk, Uzbekistan was conducted for 16 women. A training course on 'The evaluation of superior vegetable varieties" was conducted in Tashkent, Uzbekistan for 17 young scientists. Individual training in seed production was conducted for two specialists from the Kazakh Research Institute of Potato and Vegetable Growing, Kazakhstan. More than 300 people participated in Farmers' Field Days in Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

AVRDC and the Abu Dhabi Food Control Authority (ADFCA) signed a Memorandum of Understanding on 14 June 2011. A Memorandum of Understanding between AVRDC and the Ministry of Agriculture and Fisheries, Oman is under discussion and final review by the Ministry. ♦

East and Southeast Asia

In 2011, AVRDC **East and Southeast Asia** (ESEA), formerly the Asian Regional Center (ARC), had a total of 21 staff members, 7 of them assigned to the administrative office on Kasetsart University's (KU) Bangkhen Campus in Bangkok, while the remaining staff are based at AVRDC's Research and Training Station on KU's Kamphaeng Saen Campus, located in Nakhon Pathom province, about 80 km northwest of Bangkok. A research fellow from the Geography Department of the University of Freiburg, Germany, joined the regional office in November 2011 for a four-month assignment to assist in preparations for a research project on urban and peri-urban vegetable systems in collaboration with Kasetsart University and other research institutes in the region.

Regional staff participated in capacity building activities. Nationally recruited staff enhanced their English language proficiency through courses. The cucurbit breeder and his research assistant attended a training course at headquarters on Agrobase, a comprehensive database management software package for plant breeders and researchers. The cucurbit breeder attended the international training course "Putting participatory values into practice" in Sri Lanka, which was hosted by the International Water Management Institute (IWMI). AVRDC field staff participated in selected sessions of a Thai Farmer Field School to strengthen their knowledge and skills on integrated pest management practices.

Five thousand disaster response seed kits each were presented to Kasetsart University and the Royal Thai Army in May 2011 for distribution to communities affected by flooding in the provinces of Krabi and Nan. The Center itself was affected by flooding in Bangkok in the last quarter of 2011; access to the office location was blocked for a period of time, and activities were temporarily shifted to the Kamphaeng Saen campus.

The regional office continued to host AVRDC's global crop improvement program for bitter gourd (*Momordica charantia*) and pumpkin (*Cucurbita moschata*), which was transferred from headquarters to the region in 2010. The bitter gourd breeding objectives include the development of open-pollinated varieties and hybrids with

East and Southeast Asia

superior yield and fruit quality, improved disease and insect resistance, earliness, ability to set fruit in high temperatures, and high concentration of nutrients and antidiabetic compounds. Pumpkin breeding activities focus on developing open-pollinated lines and hybrids possessing short vines, superior yield, earliness, fruit size and shape uniformity, thick flesh, high intensity of carotenes, and field resistance to viruses and drought.

As part of the project "Less loss, more profit, better health: Reducing the losses caused by the pod borer (*Maruca vitrata*) on vegetable legumes," mass-production techniques for the most promising parasitoids (*Phanerotoma philippinensis*) of *M. vitrata* were developed and standardized, and corresponding training activities for partners in Vietnam and Lao PDR were conducted. The first set of field trials on the efficacy of selected biopesticides against *M. vitrata* in yard-long bean under field conditions has been conducted.

Cultivation and postharvest methods for *Polygonum odoratum, Limnophila aromatica* and *Acacia pennata* by local farmers in Nakhon Pathom province, Thailand were documented and the effect of different shading levels and water management practices on yield and antioxidant parameters was assessed through a one-year project "Effect of shading and water management on three Southeast Asian indigenous vegetables" funded by the Japan International Research Center for Agricultural Sciences (JIRCAS). JIRCAS also funded two surveys on "Fermented vegetables of Thailand" in Northern and Central Thailand from June to August, and in December 2011.

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" started with an inception workshop in March 2011 in Malang, East Java, Indonesia. The districts of Kediri and Blitar in East Java, and Tabanan and Bangli in Bali were chosen as sites for project activities. A training course on experimental design, statistics and multi-location variety trials was held in July 2011 at Udayana University in Bali.

(*l to r*) Regional Directors **Abdou Tenkouano** (Africa) and **Robert Holmer** (East and Southeast Asia) in a snake gourd arbor. The Center's global crop improvement program for cucurbits is conducted in Thailand.

In March 2011 the regional office, AVRDC headquarters, Kasetsart University, and Cornell University (USA) organized the Sixth International Workshop on Management of the Diamondback Moth and Other Crucifer Insect Pests in Kamphaeng Saen. The workshop provided a common forum for more than 100 researchers to share their findings in bioecology of insect pests, host plant resistance, biological control, pesticides, and insect management on crucifer crops. The regional office also assisted Kasetsart University in conducting

a regional workshop on Roles of Urban and Peri-Urban Agriculture for Future Food Security in December 2011 in Bangkok. The workshop was organized in cooperation with the Food Security Center (FSC) of the University of Hohenheim, Germany, with financial support of the German Academic Exchange Service (DAAD).

A major activity was the 30th International Vegetable Training Course (IVTC), held from September to December 2011 at the Research and Training Station in Kamphaeng Saen. Thirty participants from eight countries successfully graduated from the course. For the second time, AVRDC participated in the Kaset Fair, an annual week-long agricultural exhibit organized by Kasetsart University in Kamphaeng Saen. AVRDC's global work was displayed by showcasing "Home Gardens of the World," featuring AVRDC's mature technologies and improved breeding lines and varieties.

Participation in the 6th ASEAN-AVRDC Regional Network (AARNET) was important to foster closer linkages with the ASEAN nations. AVRDC is a member of the Steering Committee and has an important role in developing project proposals with AARNET members for funding and subsequent implementation. ♦

AVRDC **South Asia** currently has two international staff and six national staff located in Hyderabad and four national staff located in project sites in Jharkhand and Punjab. M.L. Chadha retired as Regional Director on April 30, 2011 and was replaced by Warwick Easdown. The office hosted a visiting Vavilov-Frankel fellowship scientist and a World Food Prize intern during the year.

The office facilities in Hyderabad were upgraded with the installation of a generator to maintain operations during increasingly common power cuts. All computers were upgraded and new publication display stands were installed. Upgraded spraying equipment and safety equipment was purchased to minimize risk to staff members. A room was converted for seed storage of 10,000 disaster seed packs with installation of shelving. Additional field storage space for seed and equipment was acquired.

The project "Improving vegetable production and consumption for sustainable rural livelihoods in Jharkhand and Punjab, India" funded by the Sir Ratan Tata Trust remains the main activity in the region, and continues to make good progress. The Trust conducted an evaluation of the project activities in Jharkhand early in the year with very positive results. A key finding was that profitability of vegetable production has increased four- to five-fold due to the project interventions. Those with home gardens have tripled their vegetable consumption and halved expenditures on vegetables. However, only half continue their gardens after one year, mainly due to problems with chickens causing damage to the gardens and difficulties in assuring water supplies.

The Gesellschaft für Internationale Zusammenarbeit (GIZ)-funded project "A better bitter gourd: Exploiting bitter gourd (*Momordica charantia*) to increase incomes, manage type 2 diabetes, and promote health in developing countries" trial on bitter gourd was successfully initiated in Hyderabad. Yields, crop and fruit characterization data were collected for 20 varieties and these will be combined with data from other sites for selection of the best lines for next year's trials.

South Asia

Legume work has progressed steadily with the introduction of new lines from headquarters, seed increase and disease screening. Vegetable soybean is gaining in popularity; more than 85% of vegetable soybean farmers consume the crop dried as dahl rather than green, and seed supply can no longer keep up with demand. A 12-month project funded by the Australian Centre for International Agricultural Research (ACIAR) for joint work with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was funded to put mungbean characterization, pedigree and molecular data online for sharing with national partners.

A total of 3000 disaster seed packs were distributed in Orissa following floods in September. Catholic Relief Services handled the distribution. More than 90% of farmers given seed in November had active gardens by the end of the year and a further 3000 seed packs are to be sent in 2012 for sowing in the *kharif* (rainy) season.

Plans to expand the South Asian regional presence to Sri Lanka continue, with a revised Memorandum of Understanding to create a joint office at the Horticulture Development Institute in Kandy under consideration. ♦

(*left to right*) **Izzy Esler**, World Food Prize intern, **Ushakiran**, from AVRDC's legume research group, **Bui Huyen**, 2011 Vavilov Frankel fellow, and AVRDC legume breeder **Ram Nair** screened mungbean lines for disease resistance in India.

The Center's work in **Oceania** was focused on the project "Integrated Crop Management Package for Sustainable Smallholder Gardens in Solomon Islands" funded by the Australian Centre for International Agricultural Research (ACIAR). Launched in 2007, the project ended in the last quarter of 2011. The main objective of the project was to evaluate integrated crop management technologies to improve vegetable production for small-scale farmers. In addition to increasing yields, it is hoped that these practices will increase incomes and improve nutrition through increased vegetable consumption, leading to enhanced livelihoods overall. This project demonstrated that smallholder gardens are socially important and have an important role in food security and the health of farm family members in the Solomon Islands.

Production technologies evaluated include improved varieties, drip irrigation technology and net exclusion technology. Training was provided to technical staff of partner organizations in conjunction with trial implementation. All trials were conducted in a participatory manner with lead farmers. The feasibility of commercial local seed production and marketing was explored. Henderson, located in the Honiara plain, was found to be suitable for production of tomato and eggplant seeds. Based on pilot study results, local production and marketing of seed could be profitable for both eggplant and tomato. Good agricultural practices promoted throughout the duration of the project included use of adapted varieties, improved nursery management practices, use of insect exclusion net, production and use of compost, and crop monitoring. Extension activities, such as field days, radio programs, dramas, and fact sheets were disseminated to promote vegetable production to different audiences and target groups.

Additional support from the Taiwan Ministry of Foreign Affairs (MOFA) further strengthened the Center's work by facilitating farmer-initiated demonstration plots for training and technology evaluation. This was an integral part of an initiative to organize farmer groups in Areatakiki to enter into a production contract with the local tourism industry. Addressing the common problem of low organic matter in tropical soils, technologies to improve soil fertility by increasing organic matter and prevention of severe leaching (e.g. compost, biochar) were explored, tried and/or disseminated among the farmers.

An ex-post evaluation survey conducted at the end of 2010 showed signs of the potential impact of the project. Farmers located in communities that interacted with the project considered the sale and profit from their vegetable production to be higher compared with that in 2008, and said their livelihoods were better compared with the start of the project.

While the project had been successful in terms of local outcomes and potential impact, the Center needs to expand its focus to have a greater impact in more Pacific island nations. Working closely with the Secretariat of the Pacific Community, the Center has started exploring liaisons with Fiji and Kiribati to scale out its work in the region. Sigatoka valley in Fiji is the largest vegetable production area of the region, while Kiribati is a prime location for atoll agricultural research. AVRDC – The World Vegetable Center is looking forward from its successes in the Solomon Islands, through targeted project funding, to improving the health and well-being of the populations of other island nations in the region. ♦

Measuring the Center's achievements against its research and development output target activities provides an indicator of success in delivering quantifiable outputs and outcomes.

In 2011, almost 90% of the thematic output targets were successfully achieved, demonstrating judicious planning and exemplary implementation of the activities. The few outputs that were not achieved (due to delayed funding, organizational restructuring or unanticipated personnel turn-around) will be carried over for implementation in 2012 or revisited for potential modification.

Researcher **Sandra Habicht** prepared bitter gourd samples for analysis. Fruit of this cucurbit species has antidiabetic properties and is the subject of a three-year research project funded by Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany (GIZ).

Achievements on Output Targets 2011

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

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

Output Targets	*Achievements*
Activity 1.1 Collect/acquire and conserve vegetable and legume germplasm	
• 200 accessions collected/acquired at the Center's headquarters • 90 accessions/breeding lines collected/ acquired in sub-Saharan Africa for safety duplication in Regional Center for Africa	• A total of 859 accessions of vegetable germplasm were assembled and registered. • A total of 169 accessions consisting of 10 crops and originating from 6 countries were received by the Regional Center for Africa.
Activity 1.2 Maintain effective regeneration of priority vegetable germplasm	
• 1712 accessions regenerated at the Center's headquarters • 500 accessions regenerated at Regional Center for Africa • Production and increase of good quality seed (18 crops for nutritional seed kit; advanced lines for multi-location and on-farm trials; maintenance of breeder materials)	• A total of 1427 accessions were successfully regenerated. Some sown accessions failed to germinate. • Out of 350 accessions sown, 304 were successfully regenerated. • Seed increase of a total of 19 lines of 4 crops (amaranth, jute mallow, vegetable soybean, tomato) was achieved.
Activity 1.3 Distribute vegetable germplasm accessions and improved lines worldwide	
• 80% of vegetable germplasm requests served • 6,000 accessions/breeding lines distributed worldwide and to public or and private partners	• More than 70% were served successfully; at least 28 seed requests are still in progress. • 4962 accessions/breeding lines were distributed from headquarters as of September 2011, and 888 accessions of 21 crops from the Regional Center for Africa to 904 recipients in 9 countries.

Activity 1.4 Safety duplicate AVRDC - The World Vegetable Center's germplasm in other genebanks	
• 1500 accessions from the Center's headquarters duplicated at National Agrobiodiversity Center, Korea and Svalbard Global Seed Vault	• Due to the seed drying facility constraints at headquarters the next seed duplication has been postponed to 2012.
• 300 accessions from Regional Center for Africa duplicated at the Center's headquarters and Svalbard Global Seed Vault.	• Samples from the Regional Center for Africa are being dried further at headquarters before duplicated in the Svalbard Global Seed Vault.
Activity 1.5 Systematically store information on conservation and distribution of vegetable germplasm in AVRDC - The world Vegetable Center's electronic databases	
• 100% of acquisition, regeneration and distribution data generated in 2010 entered into the Center's Vegetable Genetic Resources Information System (AVGRIS) and Regional Center for Africa's database	• Seed acquisition and distribution data are regularly updated and uploaded.
• Characterization and evaluation data of 2009 available in AVGRIS and Regional Center for Africa's database	• Successfully completed.
Activity 1.6 Develop strategies on in-situ conservation of indigenous vegetables	
• Community-based conservation and multiplication of selected indigenous vegetables developed in Ocampo, Camarines Sur, Philippines	• The novel community-based seed system approach has been well accepted by farmers and has led to significant production of high quality seed, which is being distributed to other farmer organizations, nongovernmental and governmental organizations.
Activity 1.7 Develop effective seed health and quarantine program at AVRDC – The World Vegetable Center's headquarters and regional offices	
• All seed shipments from the Center comply with host country regulations	• Complied diligently.
• Seed detection methods for crucifer black rot pathogen compared and modified	• The International Seed Testing Association pathogen detection procedure has been validated and confirmed. For the pathogenicity tests a modified procedure has been proposed.

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 collection determined and marker-trait associations identified

Activity 2.1 Characterize morphological traits of vegetable germplasm maintained at AVRDC headquarters and regional offices	
• 1,100 accessions characterized at Center headquarters	• 1,262 accessions were characterized at headquarters.
• 200 accessions characterized at the Regional Center for Africa based on standard morphological descriptors	• A total of 199 accessions of eight crops have been characterized at the Regional Center for Africa.
• *Momordica charantia* accessions from the genebank multiplied and preliminary evaluation completed	• A total of 345 *C. moschata* and 136 *M. charantia* accessions introduced to Thailand; 48 accessions and 38 respectively were evaluated.
Activity 2.2 Conduct molecular characterization, genetic relationship and diversity analysis of germplasm collection	
• Develop 150 simple sequence repeats (SSR) markers for both *Momordica* and *Abelmoschus* spp.	• 59 *Abelmoschus* accessions were characterized with 19 simple sequence repeats (SSR) markers.
Activity 2.3 Develop, characterize, and validate AVRDC germplasm core collections	
• African eggplant core collection initiated at Regional Center for Africa	• Activity postponed due to time and human resources constraints.
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	
Activity 3.1 Identify and characterize sources of resistance to viral diseases	
• Cucurbit germplasm screened for resistance to *Squash leaf curl Philippine virus* and *Papaya ringspot virus-watermelon strain.*	• A total of 94 pumpkin (*C. moschata*) lines were screened for resistance to *Papaya ringspot virus–watermelon strain*. Four accessions were found resistant and confirmed by double antibody sandwich enzyme-linked immunosorbent assay.
• Method for screening solanaceous germplasm for resistance to *Pepper veinal mottle virus* – Taiwan isolate developed.	• A mechanical inoculation protocol has been developed for resistance screening.
• Taiwan isolates of Solanaceae-infecting tospoviruses characterized and assessed for use in screening Solanaceous germplasm for resistance.	• T*omato spotted wilt virus, Capsicum chlorosis virus, Watermelon silver mottle virus* are now available for resistance screening in Taiwan.
Activity 3.2 Identify and characterize sources of resistance to fungal and bacterial diseases	

• Pepper accessions screened for resistance to anthracnose and *Phytophthora* blight	• Single plants of 2 accessions were found to be highly resistant to *Colletotrichum acutatum* pathotype 2. Three pathotypes of *P. capsici* have been identified.
• Tomato accessions screened for late blight resistance	• Screening is on-going for new sources of resistance.
• Cucurbit accessions screened for powdery mildew resistance	• Most cucumber entries were highly susceptible. The disease did not show much progress on pumpkin lines.
Activity 3.3 Identify and characterize sources of resistance to insect pests	
• Pepper, tomato, radish and okra accessions screened for resistance to sucking insects and broad mites, red spider mite, striped flea beetle and aphids, respectively	• 100 hot pepper lines were screened, three lines were found resistant to *Thrips palmi*. Seven accessions of radish showed medium resistance to striped flea beetles. Eight okra accessions showed reduced aphid damage.
• Eggplant accessions confirmed for their resistance to thrips	• 400 accessions were screened – eight were highly resistant and 43 were resistant to thrips damage.
Activity 3.5 Evaluate vegetable germplasm for selected nutrition-related compounds	
• African nightshade and African eggplant screened for alkaloid levels	• Analytical protocols were developed for alkaloid screening and alkaloid levels were monitored
• Major/targeted phytochemicals in commonly consumed vegetables identified	• 30 vegetables were sampled and analyzed. Field trials were conducted for comparative sampling and analysis of targeted phytonutrient content and untargeted liquid chromatography – mass spectrometry (LC-MS) profiling
• Profile and content variation of antidiabetic compounds in bitter gourd germplasm determined	• Liquid chromatography – mass spectrometry (LC-MS) phytochemical profiles were established for 23 commercial bitter gourd hybrids.
Output 4: Specialized genetic materials, molecular tools, and methods developed 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	
Activity 4.1 Develop mapping populations and identify quantitative trait loci (QTLs) for resistance to biotic stresses	
• Tomato genes associated with resistance to *Tomato yellow leaf curl virus* and bacterial wilt mapped	• Populations are being developed for tospovirus resistance, fine-mapping of bacterial wilt resistance on chromosome 6, and *Mungbean yellow mosaic virus* resistance
Activity 4.3 Conduct fine mapping of quantitative trait loci (QTLs) and develop markers for marker-assisted selection (MAS)	
• Efficiency of marker-assisted selection for selecting bacterial wilt quantitative trait loci on chromosome 12 in 'Hawaii 7996' determined	• Progress has been made, but marker assisted selection is difficult as 67 genes are involved in the respective quantitative trait loci

Activity 4.4 Assemble and develop molecular marker sets for priority vegetable crops	
• 300 new single sequence repeats (SSR) markers for pepper developed, 100 SSR markers for tomato developed	• Sufficient marker resources are available for tomato. A total of 330 SSRs for pepper in-house primers were tested in a test panel of about 15 accessions.
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 transgenic vegetables with enhanced characteristics generated where appropriate	
Activity 5.1 Allele mining to identify variation conferring superior traits	
• Allelic variation for critical genes associated with drought and heat tolerance in tomato determined	• Postponed, awaiting funding.
Activity 5.2 Characterize and validate candidate genes for heat and drought tolerance	
• Critical candidate genes for heat tolerance validated and prioritized	• Postponed, but planned to be conducted under new projects submitted for funding.
Activity 5.3 Evaluate gene function and efficacy through genetic engineering	
• RNA interference (RNAi) constructs containing *Tomato yellow leaf curl virus* intergenic region and fragments from multiple strains developed • RNAi tomato events generated	• Results suggest that the RNA interference approach has potential for improvement of *Tomato yellow leaf curl virus* resistance. • Constructs combining different viral strains of associated sequences will now be studied
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 collection and improved breeding lines	
Activity 6.1 Utilize, develop or improve Material Transfer Agreements (MTAs) for genebank germplasm, breeding lines and transgenic materials that support AVRDC's interests	
• All outgoing seed shipments comply with the Center's material transfer agreements • Incoming seed are accompanied by material transfer agreements or germplasm acquisition agreements	• All outgoing shipments complied with the Center's MTAs • Any germplasm entering the Center's premises is now required to be accompanied by appropriate documents such as a material transfer agreement, germplasm acquisition agreement (GAA) and/or letter of donation (LOD), and a Phytosanitary Certificate

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

Activity 7.1 Train human resources in vegetable genetic resources conservation, management, and evaluation using conventional and advanced techniques

• Training on germplasm conservation and management conducted	• Two trainees were trained in germplasm characterization and genebank management. A lecture was held for 30 participants on the establishment, maintenance and use of field genebanks.
• Training on use of molecular tools for biodiversity analysis and germplasm evaluation conducted	• A molecular breeding workshop was held with 12 Taiwanese participants, and 6 trainees from India were trained on molecular tools for diversity analysis.

Cleome gynandra, a C4 plant and a hardy vegetable for a changing global climate.

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

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 1.1 Develop heat-tolerant and disease-resistant tropical tomato with desirable horticultural and quality traits

Output Targets	*Achievements*
• Fresh market/dual purpose lines with various combinations of resistances to begomoviruses, bacterial wilt, fusarium wilt, early blight superior horticultural and nutritional content developed and distributed	• Lines selected in spring preliminary yield trials, seed multiplied and distributed by mid-year.
• 10-15 fresh market tomato lines with *Ty*-3 and multiple late blight resistance (*Ph*-2+*Ph*-3) advanced to F_7 generation and 2-5 F_7 lines developed via marker-assisted selection (MAS) homozygous for *Mi*-1 and *Ty*-3 genes conferring resistances to root-knot nematode and *Tomato yellow leaf curl virus* disease resistance	• Both groups are included in fall observational trials. F_7 *Ty3*+*Ph*-2+*Ph*-3 to be tested in a spring preliminary yield trials.
• 5-10 F_4 lines selected for adaptation to West Africa, including disease resistance, rainy season tolerance and good fruit quality	• Work deferred due to departure of the scientist.
• Baseline survey data on preferences and cropping patterns among tomato growers in Karnal, Haryana, India analyzed and results documented	• Data collected, compiled and is being analyzed.

Activity 1.2 Develop and distribute disease-resistant chili and sweet pepper varieties (targeting anthracnose, phytophthora blight, bacterial wilt, *Cucumber mosaic virus*, *Chili veinal mottle virus*, and/or begomoviruses)

• 1-4 advanced lines carrying resistance to two or more diseases developed	• Two entries are highly resistant to two diseases, while four are resistant to three diseases; one entry is partially resistant to *Chili veinal mottle virus, Potato virus Y* and *Phytophthora capsici*, race 1.
• Seed of 10-15 new lines distributed through the International Chili Pepper Nursery and/or International Sweet Pepper Nursery	• Seven new chili pepper lines and 10 sweet pepper lines distributed to at least 20 cooperators in 16 countries.
• Seeds of 5-10 promising pepper lines increased for use in the breeding program, or for direct release after further evaluation in Taiwan and/or Southeast Asia, or other regions	• 24 hot pepper lines and 11 sweet pepper lines increased, more than 20 lines with resistance to whitely-transmitted geminiviruses or anthracnose increased for international testing.
• Develop populations to determine inheritance of insect resistance; advance selections	• Two populations advanced by single seed descent, currently in F_5 (53 and 48 lines) for recombinant inbred line (RIL) studies.

Activity 1.3 Develop heat tolerant tropical sweet pepper	
• Test hybrid combinations and promising lines evaluated and multiplied	• 80 sweet hybrids evaluated, 6 good combinations selected for extended evaluation.
• Mechanisms and markers for heat tolerance utilized in selection methodologies	• Markers not yet found and methods for using component mechanisms (e.g. high temperature pollen germination) still being developed.
Activity 1.4 Develop short-day red onions and yellow onions for improved yield, extended shelf-life, and/or *Stemphylium* resistance	
• AVRDC onion breeding strategy document prepared	• Strategy document prepared.
• Ambient- and cold-storage facilities established in Mali for storing onions during hot summer months and net cages for seed production constructed in Mali	• Bulb storage rooms erected at Samanko station and near completion.
• Introduced open-pollinated onion lines evaluated for adaptation in Mali and backcrossed and recombined progenies evaluated for bulbing, *Stemphylium* resistance, and seed productivity	• 6 to 10 elite lines were more productive or earlier producing than the control. Tests to be confirmed.
• Bulk seed multiplication of backlog AVRDC onion lines outsourced to contractors and seeds of 5 F_7 and 3 F_6 onion promising lines (high yield, early and long-self) increased for multi local trials in West and East Africa	• 4 lines being increased by Indus Seeds and Tropicasem, Senegal contracted for bulb production and seed multiplication of 10 lines. Seeds of two F_7 and two F_6 onion promising lines were produced.
Activity 1.5 Develop heat-tolerant broccoli	
• Broccoli hybrids evaluated for heat tolerance and quality traits in Taiwan summer	• 89 broccoli hybrids were evaluated for heat tolerance and quality traits; field demonstration of three superior heat-tolerant broccoli hybrids was conducted.
Activity 1.6 Develop improved vegetable soybean and mungbean with improved nutritional and flavor qualities	
• Seed of basmati and super-nodulating vegetable soybean lines multiplied and distributed at Regional Center for South Asia	• Following new regulation, 48 accessions plus 12 F_2 had to be grown in India quarantine; only the harvested seed can be used for further purposes.
• New interspecific crosses to introgress high methionine from blackgram to mungbean conducted	• Backcrossing is being attempted.
• Identification of mungbean lines with resistance to *Mungbean yellow mosaic virus* evaluated at two hot spots	• Two mungbean lines and one urd bean line identified having *Mungbean yellow mosaic virus* resistance.

Activity 1.7 Develop cucumber lines for improved horticultural traits, disease resistance, good fruit quality, and high gynoecy	
• 100-150 F_6 families of bitter-free and high femaleness of South and Southeast Asian types evaluated and advanced	• 126 F_6 were selected, 60 lines were evaluated, and 7 lines were selected for further evaluation.
• 80-100 F_5 families of bitter-free and high femaleness of South and Southeast Asian types developed from fifteen elite varieties, evaluated and advanced	• 43 F_5 were selected, 90 F_5 families were evaluated, and 21 F_5 families were selected for further evaluation.
Activity 1.8 Develop disease resistant and high quality pumpkins (*Cucurbita moschata*)	
• 30-40 F_5 families evaluated and advanced for yield, fruit quality and field resistance to diseases	• 36 entries of F_5 families evaluated and 29 F_6 families will be planted and mass selection is to be continued.
• *Zucchini yellow mosaic virus*-resistant *C. moschata* BC_4S_1 and BC_5 populations evaluated and advanced	• 19 BC_5 families were derived from 9 *Zucchini yellow mosaic virus* (ZYMV) resistant BC_4 plants and 226 ZYMV-resistant BC_4 plants selfed. ZYMV resistant BC_4S_1 and BC_5 populations are currently in the greenhouse, and the BC_4S_2 and BC_6 seed is being generated.
• Seeds of 50 genebank pumpkin accessions multiplied and their preliminary evaluation completed	• Out of 50 accessions being multiplied,18 accessions were killed in the field with virus.
• Selected elite hybrids evaluated and selfed; 250 F_2 plants evaluated and their generations advanced	• Selections in F_2 completed and 20 F_3 families generated.
Activity 1.9 Develop bitter gourd lines/hybrids with improved yield, earliness, good fruit quality and resistance to diseases/insects	
• Seeds of 50 genebank bitter gourd accessions multiplied and preliminary evaluation completed	• Multiplication and evaluation completed, 12 accessions did not germinate.
• 350 F_2 plants and 40-50 F_3 families derived from elite hybrids evaluated and advanced	• After selection, 60 F_4 families generated.
• Multi-locational trials of elite bittergourd germplasm and commercial lines in India, Tanzania and Taiwan conducted to evaluate environment, ripening stage, local postharvest management on level of nutrients and anti-diabetic compounds in bitter gourd	• Trial in Taiwan completed and is in progress India and Tanzania.

Output 2: Indigenous vegetables improved for productivity, quality, and nutrient content **Outcome:** Lines potentially beneficial to farmers and consumers	
Activity 2.1 Develop African indigenous vegetables with superior horticultural traits	
• Multilocational trial data of African eggplant, African nightshade, Ethiopian mustard and amaranth collected and analyzed	• The data were analyzed and used to justify the varieties submitted for official release
Activity 2.2 Evaluation, seed multiplication, and distribution of elite African and Asian indigenous vegetables	
• 2-3 varieties of African eggplant, African nightshade, Ethiopian mustard and amaranth submitted for official release in Tanzania and the seed shared with partners	• One variety of African eggplant, two of African nightshade, two of Ethiopian mustard and two of amaranth were officially released and registered in the national seed catalogue
Activity 2.3 Okra breeding for West Africa	
• Source/s of resistance to root knot nematode identified and utilized in crossing program • Sterility in interspecific hybrids (*Abelmoschus esculentus* x *A. caillei*) studied and strategies proposed to overcome hybrid barriers • Selection and generation advance among and within crosses of 'local by improved lines' carried out • Preliminary studies on okra mucilage conducted, locally adapted lines shared between Mali and Niger, feedback obtained and seeds multiplied on-farm • Farmer participatory trials conducted with locally adapted lines and seeds multiplied on-farm	• Due to the termination of the Center's operations in Niger where okra breeding was conducted, none of the output targets were achieved. However, 206 regenerated germplasm lines and 50 breeding lines of okra were deposited in the Center's genebank at headquarters and with the office for West and Central Africa in Mali.
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) traits critical for particular agroecosytems and markets (3) streamlined variety release procedures, and (4) more efficient vegetable seed production	
Activity 3.1 Assemble and distribute international/regional vegetable nurseries and promising lines	
• Global distribution and testing of international chili pepper, sweet pepper, tomato, and leafy crucifer nurseries and other AVRDC-developed lines conducted	• 20 chili pepper and 18 sweet pepper line sets were distributed. Tomato lines were mostly distributed individually rather than in sets. In East Africa, a set of tomato lines was assembled for testing by seed companies but distribution was delayed due to financial constraints.
• International and regional indigenous vegetable nurseries assembled for distribution and promotion	• Assembly of indigenous vegetable nurseries was delayed due to financial constraints in the region.

Activity 3.2 Analyze and review of multi-environment testing of AVRDC – The World Vegetable Center's improved germplasm	
• Multilocation trials of African eggplant, amaranth, roselle, okra in Mali analyzed and summarized	• Due to staff changes, data collection and analysis was deferred.
• Vegetable variety trials and implications for breeding and variety release analyzed and summarized	• Due to staff changes this activity was postponed; breeders are responsible for analysis and summary of their trials.
• 1-2 fresh market/dual purpose lines with combinations of resistances to early blight, late blight and superior horticultural traits tested for adaptation to East African and submitted for official release in Tanzania	• Two tomato varieties were officially released in Tanzania and registered in the national catalogue.
Activity 3.3 Develop on-line seed request database to facilitate seed requests for AVRDC – The World Vegetable Center's improved vegetables	
• On-line databases for tomato, pepper, and root stocks updated	• Entry lists were updated periodically.
• On-line databases for leafy crucifers and selected indigenous vegetables developed	• Leafy crucifer on-line database is almost ready. Seeds have been increased. Some additional characterization information is being compiled.
Activity 3.4 Improvement of seed systems	
• Variety release and registration procedures harmonized for Tanzania and neighboring countries	• In progress.
• Locally adapted 2-3 popular open pollinated improved varieties catalogued in Niger's Ministry of Agriculture	• In progress.
• Locally adapted popular open pollinated improved varieties catalogued, at least 10 in Mali, at least 15 in Cameroon and at least 10 in Madagascar	• 23 varieties were released in Mali, 25 varieties submitted in Cameroon to be listed in the national seed catalog.
• Four-six locally adapted, popular open pollinated varieties released in Tanzania	• Nine varieties were released in Tanzania.
• Commercial seeds of newly developed AVRDC-derived varieties produced and distributed by at least one seed company in Tanzania, Cameroon, Mali and neighboring countries	• Foundation seed of new varieties of tomato 'Meru,' 'BG 24,' and okra 'Safi' were given to Alpha Seeds in Tanzania, GMR in Cameroon and Technisem in Senegal respectively to kick-start the commercialization process.
Activity 3.5 Male sterility to improve the efficiency of hybrid vegetable seed production	
• Cytoplasmic male sterile versions of additional elite chili and sweet pepper lines developed	• 15 sweet and 4 chili pepper maintainers (B-lines) were converted to cytoplasmic male sterile lines (A-lines), advanced to $BC4F_1$ generation.
• Development of sweet pepper restorers using hot pepper restorer gene from 'Susan's Joy' initiated	• Hot pepper restorer factor (Rf) backcrossed into 14 sweet pepper maintainers (B-lines); advanced to $BC4F_1$ generation.

The winners (*left to right*): Pepper Breeder **Paul Gniffke**, Entomologist **Srinivasan Ramasamy,** Virologist **Lawrence Kenyon**, Tomato Breeder **Peter Hanson**, and Plant Pathologist **Jaw-fen Wang.**

The Center's dedication and knowledge in developing improved vegetable lines and production methods for small-scale farmers was recognized when AVRDC received the Team Award of Distinction from the International Association for the Plant Protection Sciences.

The award was presented to all AVRDC plant protection specialists and breeders—past and present—and to the partners that have contributed to the Center's integrated pest management strategies for tomato, pepper, and eggplant.

PRODUCTION: Safer and sustainable vegetable production systems

Goal: Substantial contributions to safer 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

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

Output Targets	*Achievements*
Activity 1.1 Diagnose and characterize major insect pests	
• Species identity and phylogenetic relationship of the genus *Maruca* occurring on vegetable legumes in South Asia, Southeast Asia and sub-Saharan Africa established	• Samples of 16 legume species were collected from Benin and Kenya in Africa and from Lao PDR, Malaysia, Taiwan, Thailand, and Vietnam in Asia. Morphological characterization and sequence variation analysis of Cytochrome oxidase 1 and the Internal Transcribed Spacer (ITS) region are on-going.
Activity 1.2 Develop integrated pest management technologies for major insect pests	
• Major natural enemies of legume pod borer identified in Southeast Asia and parasitism of major parasitoids on legume pod borer determined	• One larval parasitoid and one egg-larval parasitoid were identified as major parasitoids with parasitism rates up to 38%.
• Control efficacy of bio-pesticides against legume pod borer determined in Southeast Asia and sub-Saharan Africa	• Three commercial bio-pesticides were effective in controlling *M. vitrata* damage on yard-long bean in Lao PDR, Taiwan, Thailand and Vietnam.
• Effects of various irrigation practices on the incidences of insect pests on onion confirmed	• Postponed due to relocation of onion breeding to Mali.
Activity 1.3 Diagnose, characterize and develop integrated management strategies for major bacterial diseases	
• Molecular markers associated with virulence of phylotype I strains of *Ralstonia solanacearum* on tomato developed	• A total of seven genes were identified to be associated with virulence expression of Pss190 strain from the screened Tn5 mutants.
• Race 3 strains isolated from potato in Taiwan characterized	• A total of 311 strains have been collected and identified to be biovar 2 and phylotype II.
• Effect of rice husk biochar on induced resistance evaluated	• Evaluation is on-going.

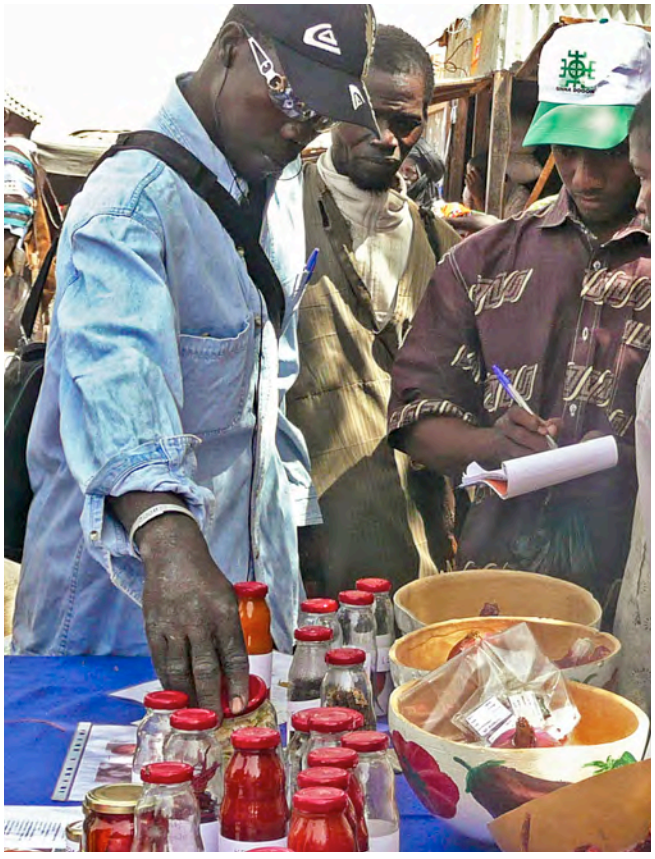
Activity 1.4 Diagnose, characterize and develop integrated management technologies for major fungal diseases	
• Phylogenic relationship and genetic diversity of *Colletotrichum acutatum* affecting pepper in Taiwan determined	• All *C. acutatum* isolates collected from Taiwan were found to be the A2 genetic group based on the diversity in the Internal Transcribed Spacer (ITS) region. Genetic diversity among the isolates was low based on the amplified fragment length polymorphism (AFLP) profile.
• Spatial and temporal distribution of *C. acutatum* pathotypes causing pepper anthracnose in Taiwan determined	• Pathotype identity of *C. acutatum* isolates collected from 1988 to 2010 in Taiwan was determined.
• Efficacy of biopesticides and cultural practices in controlling tomato fungal diseases, especially late blight, evaluated for tomato	• Four foliar spray compounds showed significant reduction of tomato late blight severity in pot trials.
Activity 1.5 Detect, characterize and explore integrated management strategies for major viral diseases	
• The important viruses, especially begomoviruses infecting *Solanaceae*, *Cucurbitaceae* and *Leguminaceae* crops in Asia and Africa, identified and monitored	• Begomoviruses and potyviruses were identified on mungbean from Vietnam, *Squash leaf curl Philippines virus* on chayote (*Sechium edule*) from Taiwan, and a previously undescribed polerovirus was detected in *Cucurbita pepo* samples from Mali. For the first time, *Cucurbit aphid-borne yellows virus* was identified in samples from the Philippines and Uzbekistan, and *Suakwa aphid-borne yellows virus* and a recombinant strain of *Cucurbit aphid-borne yellows virus* was found in samples from India, the Philippines and Thailand.
• Cucurbit, tomato, legume and pepper-infecting begomoviruses in Taiwan, Indonesia and/or Thailand characterized	• Diagnostic survey of tomato and pepper crops conducted in the Philippines and archival survey data (1998-2009) on begomoviruses infecting tomato in Taiwan was collated and analyzed.
• Full-length clone of cucurbit infecting polerovirus in Taiwan developed and genetic diversity of poleroviruses in Asia studied	• A reverse transcriptase polymerase chain reaction (RT-PCR) procedure based on the use of internal species-specific primers was developed to amplify the entire genomes directly from RNA extracts from cucurbit samples from the fields.
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 2.1 Develop technologies to improve soil nutrient use efficiency and soil sustainability	
• Simple, quick testing kits for determining nitrate and potassium in petiole sap of selected vegetables developed	• Simple soil testing kits validated for determining nitrate and potassium in petiole sap of tomato, chili and sweet pepper.
• Simple methods for assessing soil health in vegetable field reviewed and summarized	• Twelve documents, including training manual, field guide, workshop proceedings, and soil quality test kit guide were reviewed.

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 3.1 Identify major constraints and determine site-specific dissemination strategies in targeted regions	
• A check-list for implementing technology dissemination project effectively developed	• A three-page checklist of essential activities for effectively implementing technology dissemination projects was developed.
• Participatory appraisals of vegetable farming conducted in low/high-input areas of targeted countries, and dissemination strategies determined for integrated crop management technologies	• A participatory appraisal was conducted to determine the needs of farmers and other stakeholders in East Java and Bali, Indonesia.
Activity 3.2 Adapt integrated production technologies for targeted systems or regions	
• Integrated pest management packages for cucumber, eggplant, okra, sweet pepper and tomato under net-house production systems in Punjab, India and for bottle gourd and okra under open-field production systems in Jharkhand, India validated	• The new net house design adapted and developed as part of the integrated pest management practices was approved by the state government for wider promotion and adoption.
• Improved vegetable production technologies (e.g. composting, balanced fertilization technology and adaptation of mungbean and soybean rotations) adapted in Jharkhand and Punjab India	• Healthy seedling production, starter solution technology, vegetable soybean and mungbean seed production and cultivation were adapted and evaluated.
• Simple and low-cost drip irrigation technology validated in Solomon Islands	• Activities postponed until new funding and opportunities are in place.
Activity 3.3 Strengthen capacity of local partners and farmers to promote technology adoption	
• Integrated vegetable production technologies disseminated to NARES/NGOs and farmers in collaboration with local partners in India and the Solomon Islands	• Training of Trainer activities were conducted on integrated pest management and composting to support wider dissemination and adoption of improved vegetable production technologies.
• Extension and training materials published on various vegetable production technologies and Training of Trainers and mature technologies on AVRDC website updated	• The database was updated, and now 100 training documents and other topics for Training of Trainers are available on-line; three sets of training materials, 15 fact sheets and four issues of "Feedback from the Field" published.
• A framework for the Center's training evaluation activities developed and related database and evaluation updated	• An evaluation framework for training activities was developed.

Activity 3.4 Understand farmers' behavior, cost-benefit, and constraints/opportunities of technology adoption	
• Costs and benefits and constraints on adoption of microirrigation technologies analyzed and documented for selected countries in West Africa, and in tropical Asia	• Farm profitability of the African Market Garden, a widely promoted microirrigation technology, was compared in four countries in the West African Sahel (Niger, Burkina Faso, Mali and Senegal).
• Level of pesticide use and other plant protection measures adopted to control pod borer on yard-long bean in Thailand and Vietnam analyzed and documented	• Results of the surveys were analyzed and documented.
• Costs and benefits of various crop management technologies for vegetables in Solomon Islands analyzed and recommendations developed for 'best practices'	• Work is in progress. Additionally, the economic feasibility for a private sector company to contract a producer to grow seed for retail was estimated.
• Develop guidelines for pre-testing of newly developed extension material	• Guidelines are being developed.
Activity 3.5. Understand the impact of improved technologies on production systems and livelihoods	
• Socioeconomic impacts of affordable micro-irrigation technologies on vegetable farming in selected countries of Western Africa analyzed	• Farmers' perceived impacts of African Market Gardens estimated in Burkina Faso, Mali, Niger and Senegal.
• Preliminary impact assessment of introduced technologies on vegetable production in Solomon Islands documented	• Potential impacts after two years of dissemination of improved vegetable technology assessed.



Bandiagara, Mali: Center staff introduced new methods of vegetable preparation at fairs, field days, and markets.

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

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

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

Output Targets	*Achievements*
Activity 1.1 Assess consumption nutrition related outcomes of vegetable gardeners and consumers in Asia and Africa	
• Midterm monitoring for nutritional and socio-economic impact of home garden practices on village members in Punjab and Jharkhand conducted	• Independent donor-initiated socio-economic study of 18 villages and 116 beneficiaries conducted by Sir Ratan Tata Trust (SRTT). Donor found positive socioeconomic and nutritional impact of home gardens on livelihood of program beneficiaries. Nutritional yields of model home gardens have also been recalculated.
• Baseline survey on bitter gourd production, marketing and consumption in India and Tanzania conducted	• Surveys conducted on medical experts and diabetic patients, and exploratory socioeconomic background (i.e. production, market and consumer) on use of bitter gourd in managing type 2 diabetics conducted in Tanzania and India. Actual in-depth quantitative baseline consumer surveys in Tanzania and India are on-going.
• Baseline information on market oriented youth empowerment vegetable production and consumption collected	• Baseline information on 174 youth beneficiaries from eight communities out of target of 200 youth to be trained in market-oriented vegetable production have so far been collected.

Activity 1.2 Study nutritional and functional values and benefits of vegetables from tropical Africa and Asia	
• Literature on phytonutrients in leafy solanaceous crops (nightshade and eggplant) and their potential positive and negative health benefits reviewed and documented	• Literature review on phytonutrients in leafy solanaceous crops conducted and documented.
• Antioxidant analog activity of selected Southeast Asian indigenous vegetables evaluated	• Effect of different cultural management practices on antioxidant properties of sweet basil *(Ocimum basilicum*), sacred basil (*O. tenuiflorum*), Vietnamese coriander (*Polygonum odoratum*), rice paddy herb (*Limnophila aromatica*) and Acacia evaluated.
• Nutritional values of vegetables commonly consumed in Bamako, Kita, Guene, and Kirina (Mali) evaluated	• Nutritional values of onion and roselle evaluated. Analysis of other common vegetables is delayed due to late commencement of the project.
• Optimal preparation method and dosage determined for using bitter gourd in ameliorating effects of diabetes investigated in animal model	• The National Laboratory Animal Center in Taiwan facilitated the approval from their Institutional Animal Care and Use Committee for efficacy studies to be conducted. Study design of first and second animal model trial (with mice) and sample selection criteria for human study completed.
• Association of phytochemicals in selected vegetables with metabolites in animal cells and anti-inflammatory properties investigated	• Phytochemical analysis of 33 vegetable accessions including bitter gourd (i.e., with phytochemical fingerprint liquid chromatography – mass spectrometry profile documented) conducted.
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 to disaster affected areas and advocate more nutritionally effective use of vegetables.	
Activity 2.1 Develop home, school and community garden packages for poor households in Asia and Africa for technology adaptation and increased access to vegetables	
• Socioeconomic outcomes of home garden practice on village members conducted in Jharkhand and Punjab	• Study conducted. In comparison with non-practitioners, per capita weekly vegetable expenditures for home garden practitioners were found to have reduced by 50% while per capita weekly consumption increased by 200%.
Activity 2.2 Develop nutritious vegetable seed kits for disaster response in tropical and sub-tropical Africa and Asia	
• 1,000 kits per location produced in Taiwan, Thailand, India, Tanzania and Mali, and made available for distribution in response to future disasters in Africa and Asia	• A total of over 20,000 seed kits distributed in various regions for both disaster recovery and demand creation purposes. The Center currently unable to meet additional demand for seed kit due to lack of resources.
• Easy-to-understand instructions on cultivation, field management, and food preparation in various local languages prepared for publication	• Easy-to-understand instructions on cultivation, field management and food preparation of indigenous vegetables prepared in local languages for distribution in Thailand, India, Tanzania and Mali.

Activity 2.3 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 Africa	
• Nutrition improved and modified food practices and recipes recommended and promoted in Punjab and Jharkhand	• Nutritionally improved and modified food practices and recipes with sensory evaluation prepared for promotion in India. Farmer beneficiary families received appropriate training in recipe preparation.
• Nutrition improved recipes and vegetable conservation methods researched and developed for promotion in Mali	• Recipe-led nutritional promotional strategies in Mali conducted. Recipes developed have been displayed at public and social gatherings, disseminated via mass media and even through songs. Innovative communication tools used included messages branded as: women's secrets, food pyramid, annual calendar of availability of vegetables.
Output 3: Approaches to enhanced market efficiency and access developed, postharvest losses minimized and vegetable supply chain strengthened **Outcome:** Small-scale farmers and other actors in Africa, Asia and the Pacific benefit from improved market coordination along vegetable supply chains, improved postharvest practices as well as from enhanced research capacities and networks.	
Activity 3.1 Identify, map, and analyze components of supply chains for high-value crops in sub-Saharan Africa and Asia	
• Recommendations developed for strengthening market supply chains for vegetables in Malawi and Mozambique	• Study completed. A manuscript with proposed recommendations has been drafted and will be finalized and submitted for peer-reviewed publication.
• Marketing groups empowering youth for market oriented vegetable production in Tanzania mapped and identified	• Twenty youth groups (18-30 yrs) with a total 400 individuals in the Arumeru district of Arusha region, Tanzania mapped and identified.
• Baseline survey (to include current production, post-harvest and consumption practices, and vegetable variety utilization) conducted in Indonesia	• Baseline survey on current production, postharvest and consumption practices in East Java and Bali, Indonesia is at the final stage of completion.

Packaging seed: The Center works with youth groups in Africa to build interest in vegetable production and skills for the future.

Activity 3.3 Develop and enhance training curricula and materials on proper postharvest management and marketing skills for trainers in Asia, Pacific and Africa	
• Final training curricula and materials for the Farmer-Led Seed Enterprise model developed and promoted in Tanzania to improve marketing skills	• Developed curricula was reviewed and updated following a workshop on Training of Trainers' gap identification.
• Guidelines for developing good practices for establishing Farmer-Led Seed Enterprise in Tanzania developed	• As a part of the development of the guidelines, capacity of more than 20 farmers in Arusha region increased in production and marketing of African indigenous vegetable seeds as an enterprise via contract farming model with seed companies.
• Twenty youth groups for market oriented vegetable production trained in market information systems and direct product marketing skills	• Eight youth groups involving a total of 174 youths out of the annual target of 200 so far trained in vegetable market information systems are being linked to direct marketing outlets.
• Conduct participatory training for farmers using the Training of Trainers approach in Tanzania for at least 60 farmers	• More than 200 individuals from various organizations/ groups participated in the Training of Trainers workshops.
• International Vegetable Training Course curricula and lecture/training materials on vegetable postharvest, marketing and nutrition reviewed and updated annually	• Curricula and lecture/training materials on vegetable postharvest, marketing and nutrition reviewed and updated.
Activity 3.4 Strengthen postharvest research capacity of national partners through trainings and awareness raising on post harvest loses and post harvest research in national and regional level in Asia, Africa and the Pacific	
• At least 15 participants from Asia, Africa and the Pacific trained on vegetable production, postharvest and marketing	• 14 participants from Asia participated in, were trained and graduated from the International Vegetable Training Course in vegetable production, postharvest and marketing techniques.

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 information, enhanced capacities of national agricultural research and extension systems and non-governmental organizations and improved policy support.

Activity 4.1 Conduct training courses and promotion campaigns to increase production, utilization and consumption of nutrient rich vegetables in Asia and Africa

• Quarterly 2-3 day training courses on vegetable home garden production, processing and preservation delivered to youth and women groups in Tanzania	• Specialized 2-3 day training courses on vegetable home garden production, processing and preservation delivered to youth and women groups in Tanzania conducted based on requests from specific organizations (e.g. USAID-Fintrac and Hellen Keller International).
• Consumer awareness of vegetable consumption and nutrition on health promoted through field days, seed fairs, national agricultural shows and on-farm demonstration plots	• Seed fairs and field days conducted to create consumer awareness and market demand in Ebolowa and Yaoundé, (Cameroon), Arusha (Tanzania), and Kirina village (Mali). Several extension materials distributed as a complimentary dissemination strategy to farmer beneficiaries in the various regions.
• Training courses on vegetable production and processing conducted in Mali for participants from Bamako, Kita, Guene, and Kirina	• Postponed due to delayed commencement of the project.
• Twenty youth groups for market oriented vegetable production in Tanzania trained in market information systems, nutrition, consumption and utilization of nutrient-rich vegetables	• Eight youth groups involving a total of 174 youths out of the annual target of 200 so far trained in food preparation of and vegetable based food recipes.
• Farmer field days conducted in Central Asia and the Caucasus countries to promote increased production and consumption of vegetables	• Two farmer field days conducted in Central Asia and the Caucasus countries to promote increased production and consumption of vegetables. A school garden was established as part of the nutritional promotional activities.

Heat-tolerant broccoli showed promise for farmers in the tropics during a hot field day in June 2011 at AVRDC headquarters.

Although relatively small in number, scientists and supporting staff members of AVRDC – The World Vegetable Center have strong multidisciplinary competence and capability to implement research and development projects globally for the benefit of our target beneficiaries in the developing world.

AVRDC – The World Vegetable Center carries out a range of research and development acitvities, capturing opportunities and addressing constraints of the vegetable value chain. Projects are conducted around the globe and supported by traditional and nontraditional donors, covering the whole spectrum of the research and development continuum: from advanced research to adaptation of results into basic and applied development, to technology transfer and dissemination.

Roughly 1.6 billion women rely on farming for their livelihoods, and female farmers produce more than half of the world's food. The Center's proposals and projects emphasize gender awareness.

Research and Development Projects: 2011

The following restricted projects approved by donors in 2011 demonstrated our donors' confidence and acknowledgement of the Center's competence to address diverse topics of vegetable research and development: from advanced basic research to applied and adaptive research; from basic and anticipative development to fully-fledged development work; from building the capacity of our beneficiaries to strengthening the networks of vegetable enterprises all along the vegetable value chain. The Center received financial support from traditional donor institutions (e.g. the Federal Republic of Germany's Gesellschaft für Internationale Zusammenarbeit, and the United Kingdom's Department for International Development) and non-traditional donors from international philanthropic organizations (e.g. the Bill & Melinda Gates Foundation, Sir Ratan Tata Trust), the private sector (e.g. Kagome Co. Ltd., Indus Seeds) and other institutions (e.g. the Global Crop Diversity Trust).

Project Title	Donor Name	Duration
Scaling up farmer-led seed enterprises for sustained productivity and livelihoods in Eastern and Central Africa	Association for Strengthening Agricultural Research in East and Central Africa	2009 - 2012
Integrated crop management package for sustainable smallholder gardens in Solomon Islands	Australian Centre for International Agricultural Research, Australia	2007 - 2011
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 - 2015
Strengthening the Cambodia and Australian vegetable industries through adoption of improved production and postharvest practices	Australian Centre for International Agricultural Research, Australia	2010 - 2012
General operation support for AVRDC in Africa	Bill & Melinda Gates Foundation, USA	2010 - 2011
Vegetable breeding and seed systems for poverty reduction in Africa	Bill & Melinda Gates Foundation, USA	2006 - 2011
Boosting competition ability of seed industry of Taiwan in Southeast Asia	Council of Agriculture, Taiwan	2010 - 2011
Scaling up activities on indigenous vegetables for nutritional security and sustainable conservation of biodiversity in Asia (Indonesia and Philippines)	Council of Agriculture, Taiwan	2011
Varietal improvement, regional trial and promotion of heat tolerant broccoli	Council of Agriculture, Taiwan	2011
Engineering tomatoes to develop durable resistance to *Tomato yellow leaf curl virus*	Council of Agriculture, Taiwan	2011
Characterization of an okra collection using morphological and microsatellite markers	Council of Agriculture, Taiwan	2011
Improvement and inheritance study of *Zucchini yellow mosaic virus resistance* for winter squash (*Cucurbita moschata*)	Council of Agriculture, Taiwan	2011
Development of colored bell pepper varieties for tolerance to high humidity and heat, and multiple disease resistances	Council of Agriculture, Taiwan	2011
Incorporation of hot pepper restorer allele into sweet peppers using marker assisted backcrossing	Council of Agriculture, Taiwan	2011
Multiplication and characterization of genetic diversity in vegetable germplasm of ethnological and local importance in Taiwan and neighbor countries	Council of Agriculture, Taiwan	2011
Development of TYLCV-resistant fresh market tomato lines	Council of Agriculture, Taiwan	2011

PROJECTS & PARTNERS

Project Title	Donor Name	Duration
Developing management strategy based on chemical attractants for striped flea beetle (*Phyllotreta striolata)* in radish	Council of Agriculture, Taiwan	2011
Development of seed detection protocols for plant pathogenic bacteria on cruciferous vegetables	Council of Agriculture, Taiwan	2011
Biodiversity integration and rural development	Department of Animal and Human Biology University of Torino, Italy	2009 - 2012
Vegetable seed kits for immediate rehabilitation of vegetable production and consumption of vulnerable households in Tanzania	Department for International Development, UK	2011 - 2012
Adoption pathways for vegetable integrated pest management technologies reducing pesticide use and pesticide related health hazards in India	Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany	2008 - 2011
Less loss, more profit, better health: reducing the losses caused by the pod borer (*Maruca vitrata*) 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
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
Exploiting bitter gourd (*Momordica charantia* L.) to increase incomes, manage type 2 diabetes, and promote health in developing countries	Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany	2011 - 2014
Network for knowledge transfer on sustainable agriculture technologies and improved market linkages in South and Southeast Asia (SATNET Asia)	EuropeAid	2011 - 2014
Regeneration and safeguard of valuable collections of vegetable germplasm held at AVRDC - The World Vegetable Center	Global Crop Diversity Trust	2008 - 2012
Indigenous African leafy vegetables for enhancing livelihood security of smallholder farmers in Kenya	Horticultural Collaborative Research Support Program, subcontracted under Purdue University, USA	2010 - 2011
Sustainable production and marketing of vegetables in Central America	Horticultural Collaborative Research Support Program, subcontracted under the University of Wisconsin, USA	2010 - 2011
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
Effect of shading and water management on three Southeast Asian indigenous vegetables	Japan International Research Center for Agricultural Sciences, Japan	2010 - 2011
Screening for development of begomovirus-resistant processing tomato hybrid	Kagome Co. Ltd., Taiwan	2010 - 2013
Screening for breeding of tomato late blight resistance	Known-You Seed Co. Ltd., Taiwan	2009 - 2012
Diagnosis and characterization of viruses infecting cucurbit crops in tropical Asia and identification of sources of virus resistance for use in the AVRDC's new cucurbit breeding program	National Science Council, Taiwan	2007 - 2011
Classification of Asian and African indigenous vegetables for anti-inflammatory and pro-resolution nature as determined by production of prostaglandin E2 and cyclooxygenase-2 in macrophage RAW 264.7	National Science Council, Taiwan	2009 - 2011

Project Title	Donor Name	Duration
Identification of genetic determinants associated with virulence of *Ralstonia solanacearum* on a resistant tomato variety, Hawaii 7996	National Science Council, Taiwan	2009 - 2012
Local adaptation and genetic relatedness of *Ralstonia solanacearum* phylotype II biovar 2 strains in Taiwan and identification of their resistance sources in tomato	National Science Council, Taiwan	2011 - 2012
Variation and diversity of phytochemicals in vegetables affected by different production seasons and cooking methods – a plant metabolomic approach	National Science Council, Taiwan	2010 – 2012
Characterize and map late blight resistance in wild tomato accessions	National Science Council, Taiwan	2010 - 2013
Biotechnology-assisted development of virus-resistant varieties and populations of squash for climate change adaptation	National Science Council, Taiwan	2010 – 2014
Targeting Induced Local Lesions IN Genome (TILLING) of tomato for multiple virus resistance	National Science Council, Taiwan	2011 - 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 - 2014
Development of environmental friendly substances to control bacterial wilt and Phytophthora late blight of solanaceous crops	Rural Development Administration, South Korea	2010 - 2012
Establishment of screening protocol for cucurbit downy mildew and powdery mildew resistance	Rural Development Administration, South Korea	2010 - 2011
Multiplication and evaluation of tomato genetic resources for breeding for disease resistance and food-related functional traits	Rural Development Administration, South Korea	2010 - 2011
Improving vegetable production and consumption for sustainable rural livelihoods in Jharkhand and Punjab, India	Sir Ratan Tata Trust, India	2008 - 2013
Watermelon for life: the potential of African genetic resources	University of Copenhagen, Denmark	2009 - 2011
Urbanization and its impacts on the use of natural resources in Africa	University of Freiburg, Germany	2009 - 2012
Growing vegetables for improved nutrition, empowerment of women and a healthy vegetable value chain in southern Bangladesh	US Agency for International Development, Bangladesh Mission	2011 - 2012
Mobilizing vegetable genetic resources and technologies to enhance household nutrition, income and livelihoods in Indonesia	US Agency for International Development, Indonesia Mission	2011 - 2014
Development of sustainable African indigenous vegetable production and market-chain for smallholder farmers in Kenya and Tanzania	US Agency for International Development, Horticultural Collaborative Research and Support Program	2011 - 2012
Semillas de Esperanza (Seeds of Hope)	US Agency for International Development, Horticultural Collaborative Research and Support Program	2010 - 2013
Improving vegetable production and consumption in Mali	US Agency for International Development, Mali Mission	2011 – 2013
Empowering youth through market-oriented vegetable production	US Agency for International Development, Tanzania Mission	2010 -2012
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	2011 - 2014

Gregory Luther, Head of Global Technology Dissemination and his team ensure farmers have the knowledge, skills and tested technologies to plant improved chili with heat tolerance and disease resistance—and reap harvests like this one in Indonesia.

Global Support

Office of the Deputy Director General - Research

The **Office of the Deputy Director General for Research** has a leadership and oversight role on the Center's thematic research and development activities globally (Global Themes: Germplasm, Breeding, Production and Consumption), supported by the regional offices, Grants and Partnership Development, Biometrics, Communications and Information, Information Technology and Global Technology Dissemination. This role requires judicious balancing of resources against the global opportunities and challenges, and also the careful balancing of research and development components within the Center's portfolio of activities.

The Deputy Director General for Research leads the team in interacting with donors and partners to source funding for projects on vegetable research and development. This has required close contact with some donors, and a rapid turnaround of concept notes leading to successful funding. Substantial input is provided with respect to developing realistic indicators and measuring performance and attainment of those indicators as required by some of the donors to the Center's core funds. The quality of project proposals is also monitored through a stringent process to ensure proposals are in line with both the Center's mission as well as the requirements of the donors. The Center's agreements, contracts and Memoranda of Understanding or Agreement are also assessed and pass through rigorous checking before approval to commit the Center to any course of action is given.

Assuring the quality of the Center's documentation is also under the purview of the Deputy Director General for Research and includes processes for internal peer-review and quality control. This documentation includes peer-reviewed publications, conference papers and posters, public relations documentation, Center documentation such as the *Year in Review*, *Medium-Term Plan* and *Annual Report*, press releases and extension documents.

The Deputy Director General for Research takes the lead in monitoring and resolving intellectual property issues encountered by the Center and, with the support of a part-time lawyer, ensures that the outcomes of discussions around these issues with partners are within the Center's mission and do not impede the production of international public goods.

The Institutional Biosafety and Ethics Committee and the Institutional Research and Development Committee are both Chaired by the Deputy Director General for Research. The Institutional Biosafety and Ethics Committee has a mandate to ensure that the Center's activities involving genetically-modified organisms and any research involving animal or human trials follow all necessary protocols and procedures to minimize risk to the Center. The Institutional Research and Development Committee, comprising the Global Theme Leaders and the Regional Directors, provides advice, insight and guidance to the Center's research and development activities. ♦

Jacqueline d'Arros Hughes
Deputy Director General - Research

Office of the Deputy Director General - Administration and Services

In 2011, **Administration and Services** guided several construction, renovation, and upgrading projects to completion. The Center's analog telecommunication system at headquarters was replaced with a digital system and some cabling was changed to fiber optic cables to speed up connectivity. With these enhancing measures, voice, data and video are now integrated and optimized using a common platform, thus reducing usage and maintenance cost.

With the Ministry of Foreign Affairs' (MOFA) special funding, the Center's genebank storage facility was expanded to safely and securely house the germplasm collection for the coming decades. The genebank office and laboratory were renovated, and the working area was increased by 133 m^2. New working tables were added, and five independent rooms for research assistants or postdoctoral fellows were set up. The toilets, tissue culture room, meeting room and the air-conditioner system were also renovated.

With MOFA special funding, the Technical Services Office procured a moveable welding machine with a generator; installed anti-electromagnetic boards in the laboratory building to reduce electromagnetic radiation spillover into working areas; laid a new asphalt road surface along the front drive; built an additional underground water tank, and added decarbonizing systems for vehicle engines. The farm office replaced greenhouse exhaust fans, improved the underground water distribution system, modified transformers in the old greenhouse, built new drainage and irrigation ditches, and repaired tractor fuel injection, electric circuit, and hydraulic systems.

MOFA funds supported construction work in regional offices. In East and Southeast Asia, cold storage facilities, the plant breeding and entomology laboratory and the Kamphaeng Saen office building were renovated, and existing research and demonstration fields and irrigation facilities improved. The South Asia office was renovated and now has space for 17 staff, and a second story that could be added to allow for future expansion. A new generator was purchased in 2011 to ensure power continuity.

In Arusha, Tanzania, an auditorium was constructed and furnished, and new equipment was purchased, including a tractor and trailer; wheelbarrows; other farm implements; plough; 16-disc harrow and water pumps for farm and field work; air conditioning units; IT equipment for the office; interactive whiteboard for the training room; sound system and simultaneous interpretation system for the auditorium; a diesel generator for stabilizing the power supply; and solar power devices for energy saving. Laboratories benches/ drawers were constructed for the plant pathology and tissue culture labs.

In Samanko, Mali, AVRDC's hosting agreement with ICRISAT requires that ICRISAT be the authority for infrastructure development. Thus, a joint AVRDC-ICRISAT task force was created and work started in May 2011. A screen house was completed; an onion storage facility requires further modification, and will be completed in 2012. Air conditioners will be used to increase air circulation in the building and extend onion shelf life.

The Global Risk Management Committee met twice to discuss risk-related issues and possible solutions, and to formulate action plans. An emergency fire response drill and a half-day first-aid training course in cardiopulmonary resuscitation (CPR) were conducted at headquarters. A well-equipped first aid room was set up to provide primary care in case of emergency. A chemical explosion accident occurred at headquarters, causing minor injury to one staff member and a trainee; the cause was investigated and future preventive measures were proposed in the report submitted by the concerned supervisor.

In 2011, Thailand experienced the worst flooding-in 50 years, which affected operations of AVRDC East and Southeast Asia's Bangkhen office. The office was closed to ensure the safety of staff, and Kasetsart University offered shelter as needed. The 30th International Vegetable Training Course was carried out at AVRDC's Kamphaeng Saen facilities as planned.

To enhance the relationship between AVRDC and its host country, Taiwan, the Office of the Deputy Director General for Administration and Services coordinated a workshop and a field day in 2011 to provide capacity building for host country researchers and opportunity for interaction between AVRDC staff and Taiwan researchers. ♦

Financial Services

Financial Services continues to provide excellent financial leadership for the Center. Fundraising remains a big challenge as the world economic recession persists and costs continue to rise. By adhering to strict financial discipline, Financial Services guided the Center through a difficult year and eventually produced a positive result at year's end. A culture of careful budgetary control is now well in place and accepted by all.

In response to a recommendation in the last external program management review, the budgeting process has been improved and now embraces all regional office activities as part of the Center's global budget. The increased emphasis on cost recovery (supporting the Center's direct costs through project funding) has helped reduce costs and pressure on the Center's limited unrestricted core budget.

Maconomy, the enterprise resource planning system implemented in 2010, is now running well; Financial Services conducted training to improve the skills of users in regional offices in Africa and East and Southeast Asia. These visits enable the fixed asset module to be deployed for full use by the regional offices. A major stride was achieved in ensuring reliable, timely and relevant management reports through Maconomy by implementing the system's Analytix report writing module. This has provided in-house capability to develop more specialized reports that will aid in qualitative and timely management decisions.

The Center continued to enjoy excellent cash flow throughout the year by ensuring receipt of funds in advance and through good planning. ♦

Internal Audit

Internal Audit maintains 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, amending reviewed Standard Operating Procedures where necessary, and auditing regional office operations and the Center's internal operations or functions.

In 2011, Internal Audit reviewed financial data at the Regional Center for Africa, and audited the functions and services of the Center's Genetic Resources and Seed Unit (GRSU), Technical Services and Human Resources operations. Internal Audit worked with other staff members to inspect renovation work at GRSU and Food and Dormitory Services, and to review and update old Standard Operating Procedures.

In the audit of Technical Services, Internal Audit found certain redundant tasks and errors in utility bills could have been avoided if there had been prompt communication between the relevant groups and Technical Services. If Technical Services staff members could obtain details of the current users of greenhouses, refrigerators, water heaters, incubators and other equipment before calculating the amount and cost of utilities consumed, unexpected recalculation of the costs could be avoided and the possibility of calculation error would be lowered. ♦

Yin-fu Chang, Deputy Director General - Adminstration and Services (*right*), with **Rita Pacho Laude**, Vice Chancellor for Instruction, University of the Philippines, Los Banos.

Human Resources

The year's major activities in **Human Resources** targeted two key strategic themes: talent development and performance management.

Based on the individual performance reviews and organizational need analysis, training needs were identified. A training plan was developed by scanning the curriculum of available courses in the market, evaluating their suitability to the training needs of staff and availability of funding. For mass training needs, custom-built in-house courses were developed and delivered. Over 120 person days of training was provided to develop skills in project management, strategic research and development, English language, publications, leadership, effective communications, interpersonal relationships, supervision, etc.

An improved Performance Management System was implemented through Maconomy to enhance recordkeeping and convenience, and strengthen the goal-setting and review processes. This involved designing the system, training staff, managing the process, and evaluating the outcome. The results of Performance Reviews for 2010 were shared in the November 2011 strategic planning meeting.

Both these initiatives have helped the Center build competencies and focus staff performance to the strategic needs of the Center.

Another important activity undertaken was optimization of staff resources. Current and upcoming vacant positions (due to retirement) were reviewed to assess whether they needed to be filled to meet critical needs of the Center. Surplus and not fully utilized positions were reviewed and staff members in some of those positions were redeployed. Technical competencies that are needed for long-term research but were funded by projects were reviewed before the completion of the projects, and some positions were bridged with core funds before being supported by another project. This helped to retain critical staff competencies and maintain the continuity of ongoing research.

Human Resources also facilitated several recruitment events, contract renewals, compensation actions, development of standard costs and budgets, separations and policy/ procedures development. ♦

I.R. Nagaraj, Director, Human Resources.

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. International press coverage about the Center in 2011 grew by 60% compared with 2010. Communication & Information published 22 issues of *Fresh*, the AVRDC newsletter, distributed to more than 2500 readers; prepared promotional brochures and posters, videos, and PowerPoint presentations; and produced extension publications on various aspects of vegetable production.

The Center's editor reviewed more than 200 articles, abstracts, books, proposals, newsletters and other documents in 2011 for grammar, style and coherence. Publications produced during the year included *Proceedings of the 6th International Workshop on the Diamondback Moth and Other Crucifer Insect Pests; Vegetables for improving livelihoods in disaster-affected areas: A socioeconomic analysis of Aceh, Indonesia; Annual Highlights 2010;* and *Year in Review 2010.*

Communications and Information maintains the AVRDC website and intranet, and coordinates the Center's 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). In April 2011, the Center opened a new research facility: ***The Greenhouse***, also known as the AVRDC intranet. This internal network links all staff at headquarters and regional offices, providing news updates, training materials, an "almanac" with seminar schedules, calendars, genebank and weather statistics, and a "toolshed" with templates, manuals, directories, policies, photos, and more.

The **AVRDC Library**, a major repository of information on vegetable research, introduced a new web interface for its catalog, *AVRDC Library Online,* in August 2011 (www.avrdclibrary.org). The improved design allows researchers to conduct literature searches with ease and greater accuracy. A new feature offers users the ability to quickly search and download the Center's extension publications. 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 publications by colleagues.

In 2011, Center headquarters welcomed 825 visitors; all received briefings and tours tailored to their specific interests. Handmade vegetable soaps and porcelain teacups hand-painted with vegetable motifs were added to Center's collection of corporate gifts. ♦

The Center's vegetable soaps: They look good enough to eat, but don't be fooled!

Information Technology

The **Information Technology** team comprises two staff members at headquarters with strong linkages to the regional offices; the team functions under the oversight of the Deputy Director General for Research.

The Center has implemented a robust system for risk management with respect to data back-up. Previously, user data back-up was implemented by running Windows NTbackup to copy data from users to the server. In 2011 an automatic system back-up has been implemented with the back-up server automatically receiving regular, scheduled downloads from user data in 'My Documents' directories. One hundred and twenty computers are currently backed-up to the server automatically, sharing estimated disk space of 1500GB.

The backbone hubs/switches of the Center's network have been upgraded to support daily data flow. Thirteen intranet hubs/switches have been upgraded from the original 100Mb to 1000Mb to enhance the network speed within the Center and to reduce the back-up and download time of large amounts of data.

The Information Technology group, in consultation with other groups within the Center, is developing a wireless local area network (LAN) system at headquarters. This system will provide secure wireless access in the administration building, laboratories, Food and Dormitory Services, and selected areas around the farm and greenhouses with 14 access points/router hubs. This will improve internet connectivity with multiple devices such as laptops, net books, tablets and smart phones to increase the efficiency of the Center's research and development activities.

The Center has purchased two AGROBASE Generation II licences for the Center's vegetable breeders. The software is designed to help researchers succeed in their research, realize a return on their investment, and maintain a competitive edge. The software is installed on one of AVRDC's servers, and the Information Technology group assisted a trainer from Agronomix Software Inc. to give a training course for 15 staff members from headquarters and regional offices in March.

The Center's email is successfully running through the @worldveg.org account in Gmail, which is managed by the Information Technology staff. IT also handles system upgrades initiated by Google that affect AVRDC staff. AVRDC currently has 277 email accounts for staff at headquarters and in the regions, using approximately 450GB of storage. ♦

Lydia Wu, Training Coordinator, participated in the 2011 Seed and Seedling Festival, Tainan, Taiwan.

Global Technology Dissemination

The **Global Technology Dissemination** (GTD) group conducted a range of activities in 2011 in the areas of technology dissemination, capacity building and agricultural development.

Global Technology Dissemination led or supported a number of activities in AVRDC – The World Vegetable Center's projects in Indonesia, Bangladesh and the Pacific. Global Technology Dissemination led the initiation of a research and development project in Indonesia during the year, which included an inception workshop, participatory appraisal, project activity prioritization, research trial design, and school garden guidelines and design, among other activities. Global Technology Dissemination provided a consultancy to the Cereal Systems Initiative for South Asia (CSISA) in Bangladesh to advise on horticultural aspects, and participated in a project granted to AVRDC in southern Bangladesh. Global Technology Dissemination also facilitated farmer group organizational activities with an AVRDC project in the Solomon Islands.

The group actively disseminated technologies across all four of AVRDC's research and development themes. In collaboration with the breeding groups, Global Technology Dissemination maintained a web-based seed catalog that greatly facilitates germplasm transfer. GTD staff also promoted the Center's indigenous vegetables and improved lines of tomato, pepper and other vegetables to stakeholders in Bangladesh and Indonesia. The group frequently updated the AVRDC website to promote grafting, drip irrigation, and other technologies. GTD played a major role in producing and publishing an International Cooperators' Guide on how to conduct tomato variety trials. The group also facilitated administrative issues and logistics for trainees coming to headquarters for capacity building activities across a range of disciplines.

Global Technology Dissemination managed the Demonstration Garden at headquarters, which showcases the Center's technologies to visitors and trainees; the garden features 50-100 crop species or varieties year-round. Signs noting nutritional and other information about each crop are regularly updated. GTD staff gives visitors tours of the Garden.

GTD 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 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. In collaboration with AVRDC's regional offices, GTD produced the seeds, wrote planting instructions, and packaged and distributed seeds to partners. GTD organized the Center's exhibits at the annual "Seed and Seedling Festival and Exhibition of Agricultural Achievements," and the Center's field day, "Information Exchange and Field Demonstration of Vegetable Breeding Research" in Taiwan. The group also organized study tours for nationally recruited staff.

Global Technology Dissemination played a vital role in contributing to project proposals, especially on development-oriented aspects. The group updated the Center's mature technologies database and and uploaded it to the Greenhouse intranet to facilitate use by AVRDC staff, along with training manuals and other documents. Global Technology Dissemination worked with other groups at the Center to develop Training of Trainer manuals and extension publications that transfer the Center's technologies in ways that enable adaptation by end users. ♦

Global Technology Dissemination engages partners in capacity building and participatory exercises.

Biometrics

Biometrics evaluated experimental plans and provided statistical advice during the planning and designing of experiments, and performed data analysis for scientists and research staff at headquarters and in Africa to ensure accuracy, integrity and validity of data generated from AVRDC experiments.

Biometrics reviewed, edited, commented, and provided advice to improve annual/project reports, proposals, abstracts and papers to be submitted for publication by scientists in peer-reviewed journals. AVRDC's Biometrician attended project workshops and contributed expertise in statistical planning. To improve and enhance the skills of the Center's research staff and collaborators in conducting research and development work, AVRDC's Biometrician served as a resource person in AVRDC's 30th International Vegetable Training Course in Thailand and trained project partners in Bali, Indonesia.

Biometrics maintains the Center's database on variety releases and provided scientists with easy access to information on new variety releases for various crops in different countries. ♦

Dolores Ledesma (*center*), Biometrician, conducted training in statisical analysis for project partners in 2011—and recognized her students' effort by awarding certificates. On the right: **Joko Mariyono**, AVRDC Project Coordinator in Indonesia.

Grants and Partnership Development

The overall goal for **Grants and Partnership Development** is to provide effective and efficient institutional support for the Center's research and development agenda in terms of resource mobilization and project administration. This is realized mainly through facilitation and coordination, and in serving as a focal point for proposal development.

Grants and Partnership Development consists of two staff (a manager and an assistant). The group works in two main areas: (1) supporting the Center's resource mobilization efforts, including gathering donor intelligence and priorities; reviewing, editing and submitting concept notes and proposals; developing partnerships; and (2) supporting the Center's project administration activities, including negotiating, drafting, reviewing and editing agreements; reviewing, editing and submitting reports; and other project-specific issues.

The institutional processes and procedures for resource mobilization and project administration laid down in late 2010 were implemented; all proposals and projects now follow a fairly effective and efficient quality control process.

Special effort was made during the year to contribute substantially to a better understanding within the Center of the "why and how" of full cost recovery from projects, as well as ensuring full cost recovery as much as possible, given circumstances, on each proposal.

The Office of the Deputy Director General for Research is the oversight office for the Center's research and development agenda, so it is crucial that the office receives relevant information in a systematic and timely manner. In 2011 the group implemented a monthly project reporting system and database on resource mobilization through proposals.

Maconomy, the Center's enterprise resource planning system, has been populated with the Center's concept notes/proposals, project data and agreements.

During the year 82 concept notes and proposals were reviewed, edited and submitted to a multitude of donors. Thirty-eight technical project reports were reviewed, edited and submitted to donors and partners, in addition to submission of the financial project reports.

All agreements the Center signs with donors and partners (currently the Center collaborates with more than 170 partners across the globe) pass through Grants and Partnership Development, which supported negotiations, prepared, reviewed (legal) and edited numerous agreements. ♦

Grants and Partnership Development guides agreements such as the Memorandum of Understanding signed with the **Abu Dhabi Food Control Authority** in June 2011.

A Diverse Workforce

In 2011, AVRDC - The World Vegetable Center staff members came from 22 countries, including Taiwan. Women occupy 35% of the 59 senior staff positions.

Name	Position	Location	Nationality
Afari-Sefa, Victor	Scientist – Socioeconomics and Global Theme Leader, Consumption	Arusha, Tanzania	Ghana
Belarmino, Marilyn	Scientist – Genetic Resources	Arusha, Tanzania	Philippines
Bhattarai, Madhusudan	Agricultural Economist	Shanhua, Taiwan	Nepal
Chadha, M. L	Regional Director, South Asia (retired April 2011)	Hyderabad, India	India
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, Huei-mei	Associate Specialist, Biotechnology/Molecular Breeding	Shanhua, Taiwan	Taiwan
Chen, Jack	Postdoctoral Fellow, Molecular Entomology (left January 2011)	Shanhua, Taiwan	Taiwan
Dagnoko, Sokona	Vegetable Breeder (left August 2011)	Bamako, Mali	Mali
Dhillon, Narinder	Vegetable Breeder, Cucurbits	Bangkok, Thailand	India
Easdown, Warwick	Regional Director, South Asia (appointed 1 May 2011)	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, Tilak Raj	Technical Officer	Ludhiana, India	India
Gniffke, Paul	Plant Breeder (Pepper and Bulb Allium)	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
Huang, Jenny	Consultant, Public Relations and Partnerships (left June 2011)	Shanhua, Taiwan	Taiwan
Hughes, Jacqueline d'Arros	Deputy Director General - Research	Shanhua, Taiwan	United Kingdom
Inukonda, Nagaraj	Director of Human Resources	Shanhua, Taiwan	India
Javier, Edwin	International Variety Development Coordinator (left March 2011)	Shanhua, Taiwan	Philippines
Keatinge, J.D.H.	Director General	Shanhua, Taiwan	Ireland
Kenyon, Lawrence	Plant Virologist	Shanhua, Taiwan	United Kingdom
Knierim, Dennis	Postdoctoral Fellow in Virology (left July 2011)	Shanhua, Taiwan	Germany
Kriesemer, Simone Kathrin	Research Associate (Socioeconomics)/ Postdoctoral Fellow (left in October 2011)	Shanhua, Taiwan	Germany
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	Shanhua, Taiwan	Korea
Lin, Chih-hung	Associate Specialist, Bacteriology	Shanhua, Taiwan	Taiwan
Lu, Vincent	Internal Auditor	Shanhua, Taiwan	Taiwan

Name	Position	Location	Nationality
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
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	Dubai, UAE	Egypt
Nair, Ramakrishnan	Vegetable Breeder, Legumes	Hyderabad, India	India
Ndung'u, Philip Kamau	Regional Administration and Finance Officer	Arusha, Tanzania	Kenya
Neave, Suzanne	Project Coordinator, Solomon Islands	Honiara, Solomon Islands	United Kingdom
Öberg, Annelie	Manager, Grants and Partnership Development	Shanhua, Taiwan	Sweden
Ojiewo, Christopher	Vegetable Breeder	Arusha, Tanzania	Kenya
Olatifede, Kolade	Director of Finance	Shanhua, Taiwan	Nigeria
Rakotoarisoa, Benjamin	Liaison Officer for Madagascar (left March 2011)	Aloatra, Madagascar	Madagascar
Ramasamy, Srinivasan	Entomologist	Shanhua, Taiwan	India
Ravishankar, Manickam	Site Coordinator	Ranchi, India	India
Reddy, Vamsidhar	Project Coordinator	Hyderabad, India	India
Rouamba, Albert	Vegetable (Onion) Breeder	Bamako, Mali	Burkina Faso
Schafleitner, Roland	Head, Molecular Genetics	Shanhua, Taiwan	Austria
Tanyongana, Ronia	*vBSS* Program Management Coordinator (left May 2011)	Arusha, Tanzania	Zimbabwe
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	Shanhua, Taiwan	Taiwan
Yang, Ray-yu	Nutritionist	Shanhua, Taiwan	Taiwan

To raise awareness of the benefits of exercise in controlling type II diabetes, AVRDC staff took a "Walk for Health" on World Diabetes Day (November 14) at headquarters and in South Asia.

Research for Development

In 2011, Center researchers shared their knowledge and results in international peer-reviewed journals, at conferences, and in partnership with scientists from developing countries.

2011
(no. of scientists: 29)

2.2
Total externally reviewed publications per scientist (journal articles, books, book chapters)

1.07
Publications per scientist in journals listed with Thomson Reuters ISI

43%
Percentage of scientific papers in refereed journals, conference and workshop proceedings published with partners from developing countries

The Center's top 10 journal articles (as rated by Thomson Scientific/ISI impact factors) were published in the following journals:

- *Science* (31.36)
- *Molecular Biology* (9.283)
- *PloS ONE* (4.411)
- *Food Chemistry* (3.448)
- *Transgenic Research* (2.569)
- *Journal of Chemical Ecology* (2.486)
- *Phytopathology* (2.428)
- *Journal of Food Composition and Analysis* (2.42)
- *Plant Pathology* (2.237)
- *Annals of Applied Biology* (1.618)

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Financial Health

The Center's strong long-term financial support from its host country, Taiwan, helps to compensate for Taiwan's relatively high labor costs. Unrestricted income in 2011 comprised 62% of the total and was obtained from national governments and the private seed sector; restricted income was 38%.

	AVRDC	CGIAR **recommended range
Cash management on restricted operations *	0.45	less than 1
Adequacy of reserves	78 days	75-90 days
Short-term solvency	145 days	90-120 days

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

**** Consultative Group on International Agricultural Research**

Finance Director **Kolade Olatifede** helped staff in East and Southeast Asia and other regional offices get maximum benefit from Maconomy, the Center's enterprise resource planning system.

2011 Revenues (in '000 USD)

Unrestricted grants	**8,362**	*62%*
Restricted grants	**5,314**	*38%*
Other revenues	**156**	
Total income	**13,832**	*100%*

UNRESTRICTED GRANTS	
Republic of China	6,214
United States Agency for International Development (USAID)	700
UK Department for International Development (DFID)	1,029
Japan	37
Korea	30
Thailand	152
Philippines	50
Asia & Pacific Seed Association	150
Subtotal	8,362
Other revenues	156
Total	8,518

RESTRICTED CORE	
Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)	33
Australia/Australian Centre for International Agricultural Research (ACIAR)	248
Austrian AID	0
EuropeAID	0
Food and Agricultural Organisation (FAO)	0
Bill & Melinda Gates Foundation	1,065
Global Crop Diversity Trust	51
Republic of Germany / BMZ / GIZ	1,088
INDUS Seeds	0
Japan	9
Kagome Co., Ltd.	33
Known-You Seed Co., Ltd.	19
Korea/Rural Development Administration (RDA)	108
Rijk Zwaan	0
Republic of China / Council of Agriculture	162
Republic of China / National Science Council	204
Republic of China / Ministry of Foreign Affairs	1,676
Sir Ratan Tata Trust	184
United States Agency for International Development (USAID)	361
Volkswagen / University of Freiburg	33
Training funds and other revenue	40
Subtotal	5,314
TOTAL	**13,832**


GO COOLS HOT SNAX
Coca-Cola

Acronyms and Abbreviations

AARNET	ASEAN-AVRDC Regional Network
ACIAR	Australian Center for International Agricultural Research
ADFCA	Abu Dhabi Food Control Authority
ARC	Asian Regional Center
AVGRIS	AVRDC Vegetable Genetic Resources Information System
CPR	Cardiopulmonary resuscitation
CWANA	Central & West Asia and North Africa
DAAD	German Academic Exchange Service
FSC	Food Security Center, University of Hohenheim, Germany
GAA	Germplasm Acquisition Agreement
GIZ	Gesellschaft für Internationale Zusammenarbeit
GRSU	Genetic Resources and Seed Unit
GTD	Global Technology Dissemination
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ITS	Internal transcribed spacer
IVTC	International Vegetable Training Course
IWMI	International Water Management Institute
JIRCAS	Japan International Research Center for Agricultural Sciences
KU	Kasetsart University, Thailand
LAN	Local area network
LC-MS	Liquid chromatography – mass spectrometry
LOD	Letter of Donation
MAS	Marker-assisted selection
MGD	Millennium Development Goals
MOFA	Taiwan Ministry of Foreign Affairs
MTA	Material Transfer Agreement
QTL	Quantitative trait loci
RCA	Regional Center for Africa
RIL	Recombinant inbred line
RNAi	RNA interference
RT-PCR	Reverse transcriptase polymerase chain reaction
SAIC	Al Sulaiteen Agriculture and Industrial Complex
SRTT	Sir Ratan Tata Trust
SSR	Simple sequence repeats
UAE	United Arab Emirates
USAID	United States Agency for International Development
vBSS	Vegetable Breeding and Seed Systems for Poverty Alleviation in sub-Saharan Africa

(*facing page*) A pilot study conducted in 2011 found that production and marketing of eggplant seed could be a profitable enterprise in the Solomon Islands.


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