

TOGETHER: Partners in research and development



In fields and laboratories, in marketplaces and meeting rooms, AVRDC – The World Vegetable Center joins with partners across the globe to ensure vegetables are on the table: in homes, in markets, and wherever agricultural policy is made.

Meet some of our partners and the Center staff who work together to improve the health, nutrition, and livelihoods of millions.

AVRDC - The World Vegetable Center
2008-2009 Annual Highlights



The Center

AVRDC – The World Vegetable Center, founded in 1971, is the world’s leading nonprofit institute for vegetable research and development. The Center nourishes people and nurtures the Earth by effectively mobilizing resources from the public and private sectors to promote the safe production of nutritious, health-promoting vegetables. 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 diets for all.

Prosperity for the poor, health for all

Finding strength in common interests and shared goals

The milestone year of 2015 for the United Nations' Millennium Development Goals (MDG) is rapidly approaching, and AVRDC – The World Vegetable Center has substantially increased its efforts to contribute positively to their attainment. By working together with a range of partners based around the world, we are creating and participating in global partnerships for development (MDG 8). We have worked closely with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Center for Agricultural Research in the Dry Areas (ICARDA), the International Food Policy Research Institute (IFPRI), associated national agricultural research systems (NARS), nongovernmental organizations (NGOs), and private sector companies in the continuing battle against malnutrition and poverty (MDGs 1, 4, 5, and 6).

We value our longstanding partnership with South Korea—one of the Center's founding nations—which has continuously funded our collaboration with its Rural Development Administration's National Institute of Horticultural and Herbal Science; the institute has regularly seconded their senior scientific staff to assist us at our research headquarters in Taiwan. Kasetsart University in Thailand has provided us with a strategic base for activities in East and Southeast Asia, from which we continue to offer an annual major training course for capacity building in horticultural science.

None of our scientific partnerships could survive without the generous funding we receive from the Council of Agriculture and Ministry of Foreign Affairs of our host country, Taiwan. We equally value the long-term contributions and support of donors including the UK's Department for International Development (DFID), the German Federal Ministry for Economic Cooperation and Development (BMZ) through the Agency of Technical Cooperation (GTZ), the Australian Centre for International Agricultural Research (ACIAR), and the US Agency for International Development (USAID), plus many others.

Extending our reach

Having a network of strong and like-minded partner organizations enables the Center to extend the reach of its research activities. Formal agreements such as those signed with Birsa Agricultural University in Jharkhand State in India (local), with the Cameroon Ministry of Scientific Research and Innovation (national), and with the Secretariat of the Pacific Community (regional) ensure our work has relevance at all levels.

We also build informal networks—with local partners, such as with the Island Food Community in Pohnpei in the central Pacific, to global entities like the Worldwatch Institute—to share knowledge and exchange expertise. This combination of formal and informal networking leads to the broader distribution and use of AVRDC-derived germplasm and technologies. The

Center provides either finished or parental material for consideration to national breeding programs, which in turn release new varieties based on AVRDC germplasm to their farmers, such as hot pepper 'Uchkun' in Uzbekistan and mungbean 'Maash 2008' in Afghanistan. Each year our genebank dispatches between 6000 to 10,000 germplasm samples to researchers around the globe.



Strengthening the knowledge value chain by incorporating diversity

AVRDC's Innovation Platforms for horticultural seed production and use in Africa, which were supported by the Bill & Melinda Gates Foundation, have brought together government, private sector companies, farmers, traders, universities, and other stakeholders to develop the seed sector in sub-Saharan Africa. The diversity of views represented and the participatory manner in which they were solicited have led to healthy and robust reforms of the business environment concerning vegetable seed.

The Center aims to build similar partnerships with the medical profession. Through the Asia-Pacific Regional Meeting on Food Security and Health and the subsequent creation of an informal mega-regional platform for collaboration, partners in both the health and agriculture sectors have been enlightened about their roles in alleviating malnutrition and promoting good health through balanced diets. This is a vital development for the Center; our future work will target opportunities for balancing diets in communities heavily burdened by growing levels of obesity, type II diabetes, and related illnesses.

Partners help each other through tough times

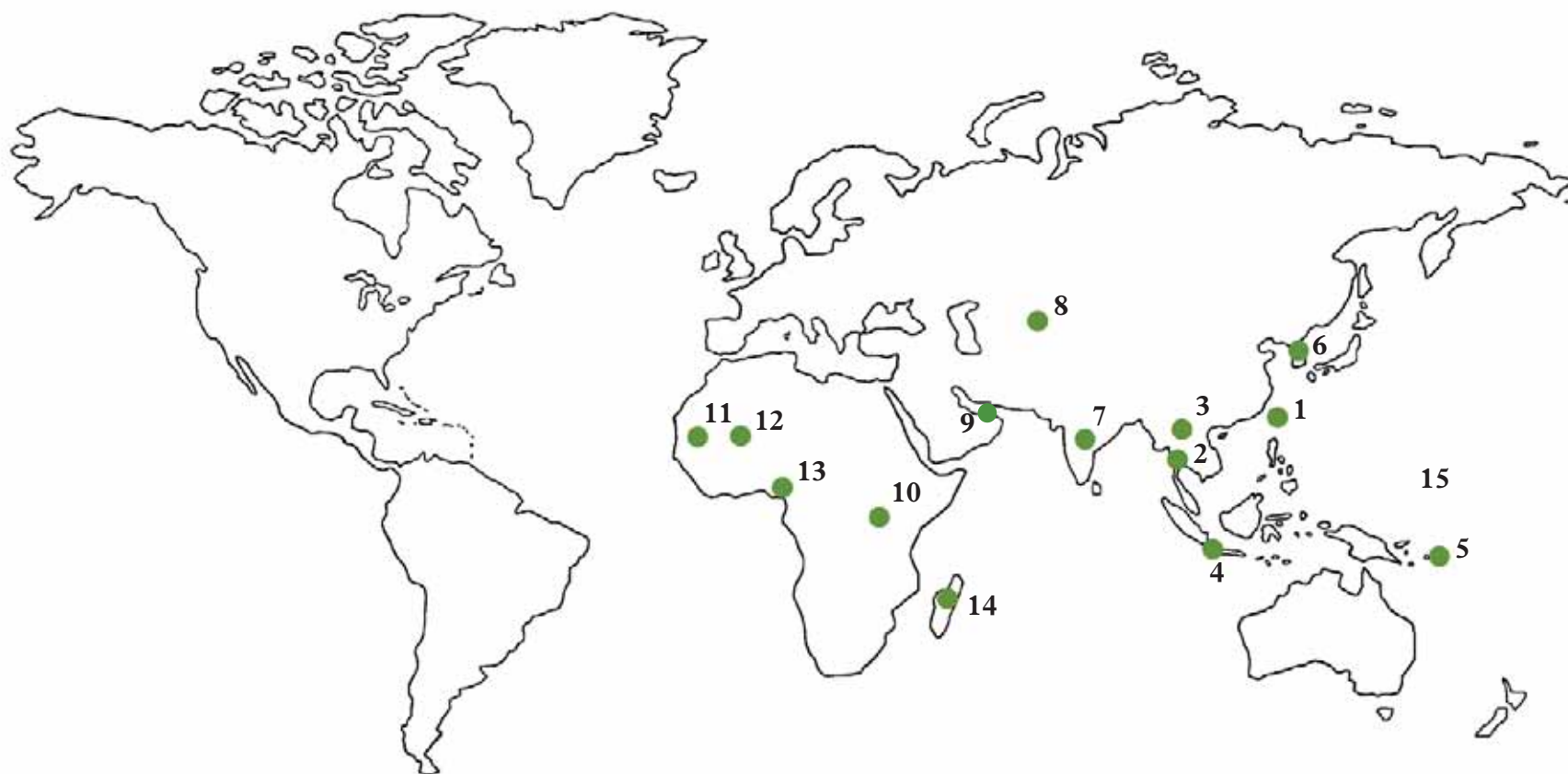
Governments and NGOs often request that the Center provide immediate short-term help to people affected by natural disasters. Until recently, we have had to say no to such requests due to a lack of funds for seed bulking and pre-positioning of nutrition-rich multi-seed packs suited to a range of climates and needs. However, the Center did provide disaster relief seed and back-up technological support for victims of the 2004 tsunami disaster in Aceh, Indonesia and communities ravaged by Typhoon Morakot in Taiwan in 2009. Partners on the spot, such as World Vision Taiwan, are best situated to distribute seed kits, which provide a range of fresh vegetables for families in as little as 40 days. We believe our seed kits could supplement efforts by the World Food Program to replenish food stocks after disasters. Providing seed for disaster relief will be an important role for the Center to develop with its partners in the coming years.

A handwritten signature in black ink that reads "J.D.H. Keatinge". The signature is written in a cursive, slightly slanted style.

J.D.H. Keatinge
Director General

2 Where we are

Regional locations



- 1_AVRDC - The World Vegetable Center, Headquarters - Taiwan
- 2_Regional Office, East and Southeast Asia - Bangkok, Thailand
- 3_Project Office - Vientiane, Lao PDR
- 4_Project Office - Central Java, Indonesia
- 5_Project Office - Honiara, Solomon Islands
- 6_Subregional Center - Suwon, South Korea
- 7_Regional Center for South Asia - Hyderabad, India
- 8_Subregional Office for Central Asia and the Caucasus - Tashkent, Uzbekistan
- 9_Regional Office, Central and West Asia and North Africa - Dubai, UAE

- 10_Regional Center for Africa - Arusha, Tanzania
- 11_Subregional Office for West Africa - Bamako, Mali
- 12_Project Office - Niamey, Niger
- 13_Project Office - Yaoundé, Cameroon
- 14_Project Office - Antananarivo, Madagascar
- 15_Oceania (through Headquarters, Taiwan)

Research and development

Our 5 themes

GERMPLASM

Conservation, evaluation, and gene discovery

BREEDING

Genetic enhancement and varietal development

PRODUCTION

Seed and safe vegetable production systems

MARKETING

Postharvest management and market opportunities

NUTRITION

Nutritional security, diet diversification, and human health

...PRODUCTION

During 2008-2009, more than 5500 extension workers, farmers, and small-scale entrepreneurs attended Farmer Field Schools, "training of trainers" workshops, regional training courses, and other learning events hosted by the Center and its partners on topics ranging from postharvest processing and home gardening to integrated pest management, grafting, and other crop protection and cultivation methods. The training continues long after the courses end, as participants' new knowledge ripples out through their communities by example. Training has a positive effect on farmers' actions and local policies related to improved agroecosystem management. *Page 10*

...NUTRITION

Typhoon Morakot swept across Taiwan from August 7-10, 2009, causing widespread destruction. AVRDC – The World Vegetable Center donated 1850 Disaster Relief Seed Kits to World Vision Taiwan for distribution to affected communities. The kits contained seed of four quick-growing vegetable crops—okra, jute mallow, bush snap bean, and mungbean—to help 600 farming families. By preparing and storing kits of regionally appropriate, fast growing, and nutritious vegetable seed, AVRDC is ready to respond to disasters and assist those in need. *Page 14*



Partners in...

3

...BREEDING

Simple sequence repeats (SSR) are stretches of DNA containing di-, tri-, or tetra nucleotide repeat units that are abundant in plant genomes, and are the major source of genetic markers. Researchers use SSR markers to characterize germplasm, fingerprint cultivars, and map genes of interest on chromosomes to facilitate gene identification and marker-assisted selection in breeding programs. To assist national institutions and small companies with limited DNA marker capabilities, AVRDC and the Asia and Pacific Seed Association established a consortium to develop SSR markers for tomato. Eighteen seed companies joined with AVRDC to design cost-effective ways to develop 1000 markers, generate an SSR genetic map of tomato, and develop baseline DNA "fingerprint information" for tomato lines from consortium members. "The partnership has strengthened the SSR marker resources available for tomato breeders to enhance molecular breeding programs in the public and private sector," said Dr. Kadirvel Palchamy, AVRDC Molecular Breeder. "With more markers, we can rapidly identify traits of interest and get improved vegetable germplasm to farmers faster." *Page 8*

...GERMPLASM

With duplication at Korea's RDA Global Seed Hub, AVRDC's germplasm is in safe hands. Launched in 2008, the hub is the world's 6th-largest genebank. It can accommodate 500,000 accessions for medium- and long-term conservation and currently conserves a total of 272,181 accessions, composed of seed crops (159,767), vegetative crops (27,148), microorganisms (19,854), livestock (65,051), and silkworm (361). Except for the seed crops, all other genetic resources are conserved in liquid nitrogen at -196°C. *Page 6*



...MARKETING

No major vegetable seed industry exists in West Africa, while in East Africa small seed enterprises lack vegetable breeding programs. A colloquium hosted in Nairobi in 2009 by AVRDC – The World Vegetable Center's Vegetable Breeding and Seed Systems project aimed to address the issues and bring together the regulators, input dealers, farmers, and current and potential seed producers to strengthen this vital link in Africa's agricultural production. "As a result of the colloquium, an informal network evolved to raise the profile of the seed sector," said Ronia Tanyongana, AVRDC Seed Health Specialist. "National regulators are now much more aware of the importance of vegetables to the health of their populations and their economies." *Page 12*

Timeline

January

- Major survey begins to gather data on chili-growing households in selected regions of Indonesia, including tsunami-devastated Aceh

February

- AVRDC deposits 7350 germplasm accessions in the Svalbard Global Seed Vault in Norway
- Dyno Keatinge appointed new AVRDC Director General

March

- Underutilized plant species highlighted at international symposium, AVRDC's Regional Center for Africa



April

- Postharvest project in Southeast Asia assesses supply chains for five major vegetables in the Greater Mekong Subregion
- The Asian Vegetable Research and Development Center officially renamed AVRDC – The World Vegetable Center

May

- AVRDC develops and refines affordable microirrigation systems for small-scale vegetable production in the tropics
- Africa staff attend intensive 10-day plant breeding workshop at headquarters
- The Center's pepper grafting technology is introduced in training workshops in India



June

- AVRDC honored by Government of Kazakhstan for its work in Central Asia and vegetable soybean 'Universal' released in the region
- Regional Center for South Asia launches project to improve vegetable production and promote sustainable livelihoods in Jharkhand and Punjab, India



July

- AVRDC receives the Ryutaro Hashimoto APFED Award 2008 for Good Practice for eggplant fruit and shoot borer IPM strategy

August

- AVRDC project office opens in Honiara, Guadalcanal, Solomon Islands and holds its first training session
- Burundi holds first-ever workshop for Vegetable Research and Development
- AVRDC Regional Center for Africa participates in Nane Nane, the major agricultural show in Tanzania



September

- AVRDC's Vegetable Soybean Day promotes new crop in northern India; variety 'Swarna Vasundhara' developed from AVRDC lines

October

- 14th Africa Region Vegetable Production and Research Training Course held in Arusha, Tanzania.
- Groundbreaking for new regional office in South Asia, in Hyderabad, India



November

- 27th Regional Training Course held at Kasestart University's Kamphaeng Saen campus
- The Central Asia and the Caucasus Vegetable Research and Development network meets in Tashkent, Uzbekistan
- Accessions from the Center's genebank duplicated for safety at the National Agrobiodiversity Center of Korea

December

- AVRDC signs Letter of Agreement with Birsa Agricultural University in Punjab and Memorandum of Understanding with Ministry of Agriculture, Turkey
- AVRDC's new nethouse design developed with Punjab Agricultural University makes safe farming attractive to Punjab vegetable farmers



2008

January

- AVRDC vegetable seed adapted to drought benefits small-scale farmers in Niger

February

- 'Kiboko' and 'Phindu,' late-blight resistant tomato varieties developed from AVRDC lines, released in Tanzania and Malawi, respectively

March

- The Center's four-step integrated pest management strategy to control eggplant fruit and shoot borer with pheromone traps spreads throughout India
- Tomatoes with high beta-carotene (the precursor to vitamin A) evaluated for adaptation to semi-arid conditions in West Africa

April

- AVRDC breeders introgress multiple *Ty* genes from wild tomato species into existing tomato lines, producing tomatoes with resistance to whitefly-transmitted begomoviruses
- Two improved mungbean varieties—'Maash-2008' and 'Mai-2008'—released in Afghanistan
- The Center and the Secretariat of the Pacific Community sign a Memorandum of Agreement to foster cooperation, and improve scientific research and capacity building in Oceania

May

- The ASEAN-AVRDC Regional Network for Vegetable Research and Development (AARNET) meets to further collaborative efforts

June

- The Center's pepper grafting technology reduces disease incidence by 90% and boosts yield by more than 100% in the hot-wet tropics
- Community gardens established in Mali increase vegetable production and reduce poverty



July

- Ninety new cucurbit accessions boost the AVRDC genebank's *C. moschata* collection to 400

August

- AVRDC promotes seed industry development at the first All-Africa Horticultural Congress in Nairobi, Kenya
- The Center plays a key role in the Roundtable on Food in Health Security in the Asia-Pacific Region in Taipei

September

- *Discovering Indigenous Vegetables*, a full-color book published by the Center featuring 60 edible, nutritious plant species that are important sources of food in times of scarcity, receives wide acclaim

October

- Competitive trials in Central Asia and the Caucasus showcase more than 50 accessions of 10 vegetable species introduced by AVRDC – The World Vegetable Center
- AVRDC recognized by the International Food Policy Research Institute for helping transform mungbean and promote its use in crop rotations

November

- Plant pathologists from AVRDC – The World Vegetable Center join the global New Initiative on Late Blight.
- The Center presents World Vision Taiwan with nutritious, fast-growing vegetable seed to distribute to 600 households devastated by Typhoon Morakot

December

- Building on its presence in Central Asia, AVRDC adds West Asia and North Africa (CWANA) to the regions it serves; the CWANA office is located in Dubai, United Arab Emirates.

2009



"In a world where the lives of so many people are threatened by hunger and malnutrition, climate change, water shortages, loss of biodiversity, and rising energy and food prices, the secure conservation and optimal use of genetic diversity—the building blocks of agriculture and the basis for adaptation to change—is a challenge for all. Working together with national programs maximizes opportunities to respond adequately to new challenges, secure agricultural biodiversity, and enhance its use for the benefit of future generations."

— Andreas Ebert
Genebank Manager
Global Theme Leader,
Germplasm



GERMPLASM

COLLECT, CONSERVE, AND DISTRIBUTE VEGETABLE GERMPLASM, EVALUATE THE COLLECTION FOR DESIRABLE TRAITS, CHARACTERIZE SPECIES USING MOLECULAR TOOLS

Building strong links with genebanks around the world protects an irreplaceable collection of vegetable germplasm

Safety in numbers

Duplication of valuable, unique germplasm at other genebanks in other locations—ideally in other countries or regions—is an important means to manage risk and ensure the safety of a genebank collection.

In November 2006, Korea's Rural Development Administration (RDA)—a central government organization responsible for agricultural research and extension services—completed the construction of the National Agrobiodiversity Center (NAC), a modern genebank facility with a holding capacity of 500,000 accessions. RDA was willing to take on international responsibility for the conservation of genetic resources for food and agriculture, and in August 2008 this led to the recognition of the RDA genebank by the Food and Agriculture Organization and the Global Crop Diversity Trust as a global repository or hub for safeguarding germplasm duplicates of national, regional, and international genebanks. Shortly thereafter, AVRDC signed a letter of agreement with Korea's new Global Seed Hub and took another step toward protecting a significant part of the world's heritage of agricultural biodiversity.

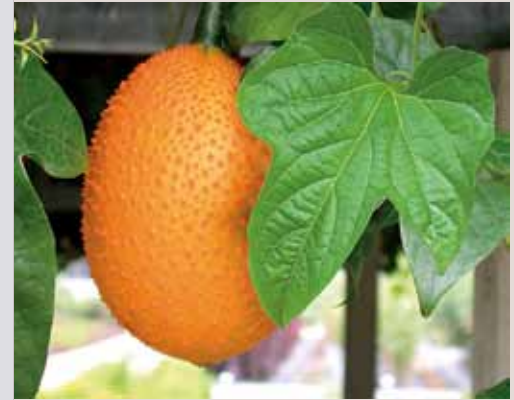
The agreement was the Center's first black-box arrangement with an active genebank. Under previous safety deposit agreements with different genebanks, the duplicated germplasm accessions became part of the active collection of the recipient genebank, depriving the Center of any control over its duplicated germplasm. With a black-box arrangement, the recipient genebank stores the duplicates under optimum long-term storage conditions without ever touching the seeds. The seed

donors decide when they will access the seed for germination testing or reintegration of part or all of the duplicated germplasm.

This kind of duplication and ease of access is important for the smooth functioning of the AVRDC genebank. With black-box storage in Korea, AVRDC now has immediate access to its seed if loss or damage occur to the original germplasm at AVRDC headquarters in Taiwan. Although the Center has deposited 9100 accessions in the Svalbard Global Seed Vault in Norway, the vault is not an active genebank and seeds usually can be accessed only with several months' prior notice.

At RDA's Global Seed Hub, sealed boxes shipped from AVRDC are safely lodged under optimal long-term conditions at the RDA genebank. The Center now stores more than 5000 accessions of vegetable germplasm comprising 13 genera and 61 species at the hub. A new shipment of recently regenerated accessions is in preparation for safety deposit in Korea, likely to be sent by the end of 2010.

The partnership between AVRDC and RDA has grown since the first seed shipment was sent from Taiwan to Korea in May 2009. AVRDC Genebank Manager Dr. Andreas Ebert has made presentations on a range of different topics during two international workshops held at NAC in Korea for participants from across Asia to build capacity for national staff involved in plant genetic resource conservation and use. The fruitful educational exchanges will continue, expanding the knowledge of all partners involved and ensuring generations to come will have the means to develop crops upon which future food security will depend.



- ▶ AVRDC – The World Vegetable Center maintains the world's largest public sector collection of vegetable germplasm with more than 57,000 accessions at its headquarters in Taiwan. It conserves the largest collections of tomato and *Capsicum* worldwide and is the second largest holder of eggplant germplasm.
- ▶ The genebank at AVRDC's regional office in Tanzania contains more than 2500 accessions, mostly of African indigenous vegetables.
- ▶ AVRDC's genebank stores the genetic material needed to develop new vegetable lines with multiple disease resistance and the ability to thrive in a changing climate.
- ▶ Wild relatives of commercial vegetable crops conserved at AVRDC contain genes for disease resistance, tolerance to abiotic stress, and other valuable traits.

"Disease-resistant varieties are the most effective, cheapest, and easiest way to control tomato diseases to benefit small-scale farmers. AVRDC is the first to develop and distribute open-pollinated lines with multiple *Ty* resistance for small-scale farmers."

-- Peter Hanson
Tomato Breeder
Global Theme Leader,
Breeding



BREEDING

PRODUCE LINES TO THRIVE UNDER CHANGING CLIMATIC CONDITIONS AND TO OVERCOME THE CONSTRAINTS OF VEGETABLE PRODUCTION IN THE TROPICS



By stacking multiple genes for resistance, breeders develop a tomato that's a monument to better pest control

The great pyramid

Producing a good crop of tomatoes in the tropics and subtropics challenges the best of farmers. Fighting pests and diseases is a never-ending battle, and in some cases the pathogens have the upper hand: For instance, tomato yellow leaf curl virus disease (TYLCVD) leads to 100% crop loss if the infection occurs at an early stage.

Tomato yellow leaf curl virus disease is caused by begomoviruses transmitted by the whitefly, *Bemisia tabaci*. Farmers often misuse pesticides in an attempt to control whitefly, and as a result *B. tabaci* has developed resistance to the agrochemical arsenal.

AVRDC – The World Vegetable Center breeders aim to develop disease-resistant tropical tomatoes that allow farmers to reduce pesticide use and produce good harvests. In 2009, AVRDC breeders led by Dr. Peter Hanson had a breakthrough: Through “gene pyramiding”—combining multiple *Ty* genes into AVRDC lines—breeders developed tomatoes with resistance to several whitefly-transmitted begomoviruses that cause TYLCVD.

Before any pyramiding could be done, however, breeders around the world had to find the *Ty* genes by evaluating hundreds of tomato accessions. Researchers at the University of Florida USA (*Ty*-1, *Ty*-3), Hebrew University in Israel (*Ty*-1), and Hisar University in India (*Ty*-2) found the genes they were looking for in some accessions of wild tomatoes *Solanum habrochaites*, *S. chilense*, and *S. peruvianum*. AVRDC obtained different lines with one or more *Ty* genes, and crossed its tomato lines with these sources. Using molecular markers, AVRDC breeders then

selected lines carrying multiple resistance genes.

Gene pyramiding is a breeding technique used to introduce multiple genes into a plant, each of which imparts resistance to a specific pest or disease. Because a pest must overcome all of the resistance genes simultaneously to survive, it is more likely the vegetable line or variety will retain its resistance over a longer period—perhaps for several decades.

Long-term disease resistance for vegetable crops is a much sought-after goal, if an elusive one. The attacking pest or disease and the defending host are locked in a perpetual struggle for dominance. Although the host may develop the means to fend off an attack, the pest evolves and may develop new abilities to break down the plant's defense mechanisms. AVRDC's disease-resistant lines coupled with good agricultural practices such as the use of net houses or net shelters to exclude whitefly offer farmers an integrated strategy for safe tomato production.

Besides holding disease at bay, there's an additional (battle)field objective the *Ty*-resistance varieties must conquer: Farmer approval. These new lines must satisfy yield and fruit quality requirements of farmers and markets. Multilocation trials are ongoing in Mali and Tanzania in Africa, and in Karnal, northern India to solicit farmers' impressions, comments, and observations. Socioeconomics researcher Dr. Simone Kathrin Kriesemer is conducting participatory evaluations with farmers in Karnal to help determine which varietal traits are most important and how economic standing, gender, or other factors affect farmers' choice of tomato variety.



- ▶ Hundreds of tomato accessions were screened by tomato researchers in different parts of the world for TYLCVD resistance. Some accessions of wild tomato species *Solanum habrochaites*, *S. chilense*, and *S. peruvianum* had the resistance breeders sought.
- ▶ Tomatoes are the most important horticultural crop worldwide.
- ▶ Gene pyramiding introduces multiple genes into a plant, each of which imparts resistance to a specific pest or disease. Because a pest must overcome all of the resistance genes simultaneously to survive, it is more likely the variety will retain its resistance over a longer period.
- ▶ AVRDC researchers also have identified tomato accessions conferring tolerance to high temperatures and drought. The Center bred the world's first heat-tolerant lines of tomato—a boon for farmers and consumers in the tropics.

"All of the project team members and farmers contributed to the success of this project by bringing different skills to the table and utilizing their resources efficiently to create positive impacts in the tsunami-affected farming communities of Aceh."

-- Greg Luther
Head
Global Technology
Dissemination



PRODUCTION

IMPROVE SEED SUPPLIES OF SUPERIOR VEGETABLE LINES FOR POOR FARMERS AND PROVIDE RESEARCH AND LEADERSHIP TO HELP THEM PRODUCE VEGETABLES SAFELY

An effort to rehabilitate and increase vegetable production in the wake of a devastating wave

New growth for Aceh

Indonesia suffered the most damage and loss of life of all the countries struck by the tsunami on December 26, 2004. Up to 92,000 farms and small enterprises that had provided employment for roughly 160,000 people were destroyed partially or completely, and the massive wave affected nearly 40,000 hectares of agricultural land.

In response to the disaster, AVRDC - The World Vegetable Center led a consortium of partners to restore and enhance food security, nutrition, and livelihoods through vegetable production in Aceh province. The Assessment Institute for Agricultural Technology - Aceh, the Food Crops Agricultural Service - Aceh, Australia's New South Wales Department of Primary Industries, the Indonesian Vegetable Research Institute, nongovernmental organizations Keumang and Austcare, and Syiah Kuala University joined AVRDC in the effort to deal with tsunami-affected soils and build technical capacity among researchers, extension specialists, and farmers in integrated soil and crop management for vegetables.

The project began with a participatory assessment in 2007 in five districts and a soil survey covering 23 sites to determine the scope of need and plan appropriate interventions. Farmers participated in on-farm research trials to test compost, animal manures, lime, and inorganic fertilizers for soil remediation to grow chili, cucumber, and amaranth, and evaluated AVRDC's "starter solution" technology to give vegetable seedlings a boost. More than 40 governmental and NGO agricultural staff participated in workshops on research methods and experimental design, and 240 farmers shared

their opinions and observations in a baseline survey.

In 2008, a Training of Trainers workshop on integrated crop management for chili pepper and other vegetables drew 35 participants, including 20 Farmer Field School facilitators. These facilitators went on to host 77 Farmer Field Schools adapted to the specific needs of Aceh farmers, with 1648 farmers attending.

An evaluation of the Farmer Field Schools in 2009 showed that farmers' overall chili farming knowledge improved through participation in the field schools. Their awareness of pests, diseases, and natural enemies increased, and many noted how the misuse of pesticides affects human health, kills natural enemies and other beneficial organisms, contaminates soil and the environment in general, and brings about pest and disease resistance. The farmers expressed confidence that based on what they learned in the field schools, they would be able to increase yields of chili by 30% and reduce pesticide use by one-third in the future.

Vegetable production and productivity levels in Aceh have great potential for improvement. With technical support and infrastructure, especially for managing soil fertility, pests and diseases, and water constraints, farmers in Aceh can expand vegetable farming, increase their incomes, and rebuild their lives.



- ▶ Pre-tsunami vegetable production in Aceh was limited, and few inputs were available.
- ▶ Four thousand copies of extension publications were published and distributed on natural enemies, how to make compost, starter solution technology, and chili cultivation.
- ▶ Vegetables with medium to high salt tolerance (chili pepper, cucumber, tomato, and amaranth) were selected for the project.
- ▶ After the tsunami, women became the primary vegetable crop growers, as male agricultural laborers were involved in tsunami reconstruction.
- ▶ Inundation with saline seawater altered the balance of the soil and led to potassium and calcium deficiencies in some sites, which was remedied by phosphate fertilizers, compost, and cow manure.
- ▶ In five years, capacity-building impacts should be felt extensively in Aceh through the work of partner institutions whose staff participated in the project's training activities.

"We are assisting farmers and working with partner organizations to develop a market-oriented approach to production through variety and low-input technology trials, as well as training and technical support. With an improvement in quality production, livelihoods benefit twofold: through income generation and increased home consumption, particularly as iron and vitamin A deficiency is prevalent."

-- Suzanne Neave
Project Coordinator
Solomon Islands



MARKETING

DEVELOP POSTHARVEST TECHNOLOGIES FOR FARMERS AND PROVIDE INFORMATION TO MARKET AGENTS TO ENABLE GREATER PARTICIPATION IN HIGH VALUE VEGETABLE CHAINS



Partnerships expand the Center's portfolio of postharvest activities to benefit farmers and vendors

Bringing more of the harvest home

Postharvest losses due to bad roads, less-than-optimum handling methods, and a lack of storage and processing facilities can claim up to 50% of vegetable crops. To whittle down that percentage, AVRDC – The World Vegetable Center works with interested partners from Southeast Asia to the Solomon Islands to sub-Saharan Africa to ensure harvests can complete the long journey from field to table—generating much-needed income for farmers and small-scale entrepreneurs and bringing more and better quality vegetables to consumers.

Determining where bottlenecks occur in the marketing chain is the first step in addressing postharvest issues. With funding from the Australian Centre for International Agricultural Research, AVRDC socioeconomists mapped vegetable supply chains in the Solomon Islands with assistance from the Ministry of Agriculture and Livestock and local NGO Kastom Gaden Association in December 2008. The survey team investigated how markets are organized and whether markets would be able to absorb an increased diversity of vegetables; data indicated aggregating farm produce at collection points could help stabilize supplies and provide better quality vegetables to consumers. Future market surveys will examine supply and demand in detail at markets in Guadalcanal and Malaita.

An analysis of supply chains for indigenous vegetables in Uganda and Tanzania and leafy vegetables in Cameroon revealed a lack of domestic seed and poor seed quality caused by poor handling and production practices hinders the supply of African eggplant,

nightshade, amaranth, and other nutritious and popular indigenous species. The Center's Vegetable Breeding and Seed Systems for Poverty Reduction project in sub-Saharan Africa, supported by the Bill & Melinda Gates Foundation, is releasing new and improved vegetable varieties suited to the region's four agroecological zones, and promoting quality seed production and commercialization to help increase vegetable production and consumption.

The Center's work with the Asian Development Bank, the UN Food and Agriculture Organization, Germany's GTZ and national partners in the Greater Mekong Subregion involved simple, low-cost methods for appropriate postharvest handling and processing of vegetables, such as cooling vitamin-rich leafy greens with moist sacking for transport, and layering vegetables in sturdy baskets or plastic crates to prevent damage when stacking on a truck or other vehicle. More than 650 participants attended AVRDC Training of Trainers programs hosted by Cambodia's Kbal Koh Agricultural Research Center, the Clean Agriculture Development Center in Laos, and district government bodies in Vietnam to gain hands-on practice in processing leafy vegetables, tomato, and chili by drying, pickling, or fermenting. AVRDC collaborated with Thailand's King Mongkut's University of Technology (KMUTT) to host a symposium on postharvest quality management in August 2009, and established a Greater Mekong Subregion Postharvest Technology Network with KMUTT and Kasetsart University, Bangkok to promote vegetable processing as an opportunity for small-scale entrepreneurs.



- ▶ In Nairobi, 30% of all vegetables sold are indigenous vegetables produced in peri-urban areas.
- ▶ Women produce 65% and market 89% of vegetables sold in Yaoundé, Cameroon.
- ▶ More than 90% of households on Malaita and Guadalcanal in the Solomon Islands produce vegetables, either for market or home consumption, and vegetables contribute to more than 50% of total household income.
- ▶ Farmers adopting improved postharvest technologies in the Greater Mekong Subregion increased their income by 25-30%.
- ▶ Solar drying of chili peppers reduced drying time by about 40% and reduced postharvest damage from anthracnose lesions by 70%.

"Many Asian countries such as Korea, Thailand, Taiwan, China, and others have significantly reduced poverty and largely achieved food security. These countries can play significant roles in global development by sharing their experiences in establishing effective food security programs and providing leadership and funding for regional collaboration. International cooperation should not only encourage collaborations for high technology development, but also promote cooperation in the development of pro-poor technologies to reduce the gap between rich and poor in terms of access to resources."

-- Ray-yu Yang
Nutritionist
Global Theme Leader,
Nutrition



NUTRITION

ASSESS, IMPROVE, AND PROMOTE THE NUTRITIONAL AND NUTRACEUTICAL VALUES OF VEGETABLES AND ENCOURAGE THEIR ADOPTION BY RESOURCE-POOR COMMUNITIES

A place at the table for everyone

Secure food systems are the essential prerequisite for access to sufficient and safe food for healthy lives. Despite the universal interest in food, the professions that deal most with it rarely interact. Agriculturalists view food as the output (yield) of inputs (land, seed) that make livelihoods possible. Health professionals see food as a means to deliver nutrition and promote health. The lack of connection makes it harder to deal with the role of food in health.

This situation changed when the two professions met in August 2009 in Taipei, Taiwan to discuss how to improve global food systems. The Roundtable on Food in Health Security in the Asia-Pacific Region brought together almost 40 senior agricultural, economic, and health professionals from around the world for vigorous discussions based on four theme issues: food, health, ethics and equity, and security. AVRDC – The World Vegetable Center lent organizational support to the Taiwan National Health Research Institute, the event host, and other roundtable partners including Australian Education International, the Australian Academies of Science, and the Australian Academy of Technological Sciences and Engineering.

The issues participants raised should give pause to anyone concerned about food. Per capita food production in Asia has been increasing steadily over the past 50 years, but economic and food crises in 2007 worsened food security and badly hit poor food-importing countries, including the 641 million people living in the Asia-Pacific region on less than 1 US dollar a day. In several

Asian countries, 2-6 persons out of 10 still lack access to sufficient food. Imbalanced global food systems lead to imbalanced diets, resulting in hunger, obesity, and nutrition-related disease. Roundtable participants reported that the global food system is not as secure as believed, and is highly wasteful, with up to three-quarters of all food produced never being consumed. High “by-catches” waste fish, soil nutrient depletion threatens agricultural production, and chemicals and pathogens contaminate food and threaten public health in many regions. Wealthy consumers overly concerned with “use-by” dates throw away huge amounts of usable food.

Ensuring food is available, accessible, affordable, and acceptable for all demands that agricultural and health professionals work in concert with families, farmers, distributors, processors, governments and other links in the global food chain.

AVRDC’s food-based approaches, such as home and school gardens, can help the poor and malnourished increase productivity on their land holdings. For example, a 4 x 4 m plot can supply a family of five (two adults and three children) with significant percentages of the recommended daily allowance of protein, calcium, iron, and vitamins A and C. A 10 x 18 m school garden can provide more than 140 children with half a cup of vegetables daily throughout the year. Malnutrition is typically most serious in locales where few vegetables are available at markets and jobs are scarce; home gardening is one remedy for a more secure food future.



- ▶ More than 1.02 billion people are malnourished worldwide.
- ▶ A varied diet improves nutritional quality and child growth in developing countries, increases longevity, and reduces rates of chronic and degenerative diseases.
- ▶ Research on market gardens showed that a 10 x 20 m plot for small farm families can increase family income by approximately 30%.
- ▶ Integrating home gardening programs with health and nutrition education for women ensures healthier families and communities.
- ▶ There is a need to address increased health hazards from pesticide misuse, growth hormones in food production, unregulated food additives, and processing standards in food factories in the global food system.

PERSPECTIVE: AVRDC – The World Vegetable Center

A highly diverse workforce

<i>Staff</i>	<i>Position</i>	<i>Nationality</i>
Abang, Mathew	Vegetable Breeder	Cameroon
Abdourhamane, Issoufou	Plant Pathologist	Niger
Abdulai, Mashark	Vegetable Breeder	Ghana
Acedo, Antonio	Regional Project Coordinator	Philippines
Adeniji, Olawale	Vegetable Breeder	Nigeria
Akyeampong, Ekow	Liaison Officer	Ghana
Baxter, Nathalie	Horticulturist	Australia
Belarmino, Marilyn	Genetic Resources Support Specialist	Philippines
Bhattarai, Madhusudan	Agricultural Economist	Nepal
Chadha, Madan Mohan Lal	Regional Director	India
Chagomoka, Takemore	Seed Marketing Specialist	Zimbabwe
Chang, Yin-fu	Deputy Director General – Administration & Services	Taiwan
Chung, Kyeong-ho	Biotechnologist	Korea
Dagnoko, Sokona	Vegetable Breeder	Mali
Dhaliwal, Major Singh	Vegetable Breeder	India
de la Peña, Robert	Molecular Plant Breeder	Philippines
Dibiyantoro, Anna	Project Site Coordinator	Indonesia
Dinssa, Fekadu Fufa	Tomato Breeder	Ethiopia
Diouf, Meïssa	Vegetable Breeder	Senegal
Easdown, Warwick	Donor Support and Information Technology Manager	Australia
Ebert, Andreas	Genebank Manager	Germany
Galvez, Hayde	Molecular Marker Specialist	Philippines
Gniffke, Paul	Plant Breeder	USA
Hamilton, Kathryn	Special Project Coordinator	UK
Hanschke, Oliver	Public Awareness and Information	Germany
Hanson, Peter	Plant Breeder	USA
Helsen, Jan	Project Manager	Belgium
Hughes, Jacqueline d'Arros	Deputy Director General - Research	UK
Javier, Edwin	International Variety Development Coordinator	Philippines
Joshi, Ravindra	Project Site Coordinator	India
Kaiser, Markus	Coordinator of Program and Partnership Development	Germany
Katoch, Viveka	Vegetable Breeder	India
Keatinge, John Donough	Director General	Ireland

The Center's diverse workforce reflects the institution's scope and reach, and makes a significant contribution to our dynamic and forward-thinking approach to research and development. Two measures of staff diversity are the nationalities of international staff and the gender balance.

As of December 2009, AVRDC – The World Vegetable Center had staff members from 28 different countries, including Taiwan. Of the 69 senior staff positions, Taiwan nationals represented 7%, and 29% are occupied by women.



Staff	Position	Nationality
Kenyon, Lawrence	Virologist	UK
Kouamé, Christophe	Liaison Officer	Côte d'Ivoire
Kumar, Sanjeet	Vegetable Breeder	India
Knierim, Dennis	Postdoc, Virology	Germany
Kriesemer, Simone Kathrin	Postdoc, Socioeconomics	Germany
Kwazi, Nadine Mujinge	Executive Assistant to Regional Director	Zambia
Ledesma, Dolores R.	Specialist, Statistics and Database Development	Philippines
Lu, Vincent	Internal Auditor	Taiwan
Luther, Gregory	Technology Dissemination Specialist	USA
Luther, Kartini	Assistant to the Deputy Director General - Research	USA
Maryono, Joko	Research Associate, Socioeconomics	Indonesia
Mavlyanova, Ravza	Regional Coordinator	Uzbekistan
Mecozzi, Maureen	Editor	USA
Nagaraj, Inukonda	Director of Human Resources	India
Ndung'u, Philip Kamau	Regional Administration and Finance Officer	Kenya
Nono-Womdim, Rémi	Liaison Officer	Cameroon
Ojiewo, Christopher Ochieng	Vegetable Breeder	Kenya
Olatifede, Kolade	Director of Finance	Nigeria
Oluoch, Mel	Training Specialist	Kenya
Ooi, Peter	Regional Director	Malaysia
Palada, Manuel	Ecosystem Specialist	USA
Palchamy, Kadirvel	Postdoc, Molecular Breeding	India
Rakotoarisoa, Benjamin	Liaison Officer	Madagascar
Ramasamy, Srinivasan	Entomologist	India
Rouamba, Albert	Onion Breeder	Burkina Faso
Silue, Drissa	Plant Pathologist	Côte d'Ivoire
Subramaniam, Geethanjali	Postdoc, Molecular Breeding	India
Sun, Zhanyong	Cucurbit Breeder	People's Republic of China
Symonds, Rachael	Postdoc, Molecular Breeding & Biotechnology	UK
Tanyongana, Ronia	Seed Health Specialist	Zimbabwe
Tenkouano, Abdou	Regional Director	Burkina Faso
Venuprasad, Ramaiah	Postdoc, Abiotic Stress Tolerance	India
Wang, Jaw-fen	Plant Pathologist	Taiwan
Wang, Tien-chen	Mycologist	Taiwan
Weinberger, Katinka	Socioeconomist	Germany
Yang, Ray-yu	Nutritionist	Taiwan
Yeboah, Martin Agyei	Vegetable Breeder	Ghana

Quality and relevance of current research

AVRDC – The World Vegetable Center is unique among international agricultural research institutes in having development as well as research in its mandate. During 2008-2009, more than 5500 extension workers, farmers, and small-scale entrepreneurs attended “training of trainers” and other workshops hosted by the Center and its partners in postharvest processing, home gardening, integrated pest management, grafting, and other crop protection and cultivation methods.

More than one-third of the Center’s peer-reviewed publications were produced in partnership with scientists from developing countries—a further manifestation of the Center’s commitment to development.

The publication of peer-reviewed articles in international journals is another measure of the Center’s scientific productivity and publication quality.

	Total externally reviewed publications per scientist (journal articles, books, book chapters)	Publications per scientist in Thomson Scientific/ISI journals	Percentage of scientific papers in refereed journals, conference and workshop proceedings published with partners from developing countries
2008 (no. of scientists: 66)	1.53	0.6	29%
2009 (no. of scientists: 65)	1.6	0.6	40%
Average	1.56	0.6	34%

The Center’s top 10 journal articles (as rated by Thompson/ISI impact factors) were published in the following journals and the articles presented research in plant production, plant pathology, genetics, and nutrition: *Critical Reviews in Plant Science* (6.26); *Plant, Cell and Environment* (4.66); *Molecular Plant-Microbe Interactions* (4.16); *Fungal Diversity* (3.803); *International Journal of Food Microbiology* (3.011); *Physiologia Plantarum* (2.780); *Journal of Agricultural and Food Chemistry* (2.496); *Plant Pathology* (2.368); *Plant Disease* (2.121); *Pest Management Science* (2.04)

Financial health

AVRDC – The World Vegetable Center’s financial health is measured by its cash management on restricted operations (liquidity) and long-term financial stability (adequacy of reserves).

	AVRDC	CGIAR** recommended range
Cash management on restricted operations*	0.6	less than 1
Adequacy of reserves	41 days	75-90 days

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

** Consultative Group on International Agricultural Research

The Center’s strong long-term financial support from its host country, Taiwan, reduces the need for working capital compared to many international agricultural research centers, and helps to compensate for Taiwan’s relatively high labor costs.

Unrestricted income in 2009 comprised 36% of the total and was obtained from national governments and the private seed sector; restricted income was 62%; and other income, 2%.

2009 Revenues (in USD)

Unrestricted grants	6,759	36%
Restricted grants	11,642	62%
Other revenues and cost recovery	312	2%
Total income	18,741	100%
Unrestricted grants		
Republic of China	5,619	30%
United Kingdom/DFID	807	4.3%
Thailand	140	0.8%
Asia and Pacific Seed Association	98	0.5%
Japan	65	0.3%
South Korea	30	0.1%
Subtotal	6,759	36%
Restricted grants		
Asia and Pacific Seed Association	100	0.53%
Asian Development Bank	212	1.13%
Australia/ACIAR	433	2.32%
Bill & Melinda Gates Foundation	4,117	22.00%
CIRAD	2	0.01%
Food and Agriculture Organization	1	0.00%
Forum for Agricultural Research in Africa	22	0.12%
Global Crop Diversity Trust	61	0.33%
Germany, BMZ/GTZ	1,401	7.48%
International Fund for Agricultural Development	84	0.45%
Japan	20	0.11%
Kilimo Trust	39	0.21%
Philippines	23	0.12%
Republic of China, COA	407	2.17%
Republic of China, NSC	78	0.42%
Republic of China, MOFA	4,278	22.86%
Sir Ratan Tata Trust	163	0.87%
South Korea/Rural Development Administration	58	0.31%
Training funds and others	33	0.18%
United States Agency for International Development	80	0.43%
United States Department of Agriculture	31	0.16%
Subtotal	11,643	62%
Other revenues	312	2%
Total	18,714	100%





AVRDC – The World Vegetable Center

An international nonprofit research institute committed to alleviating poverty and malnutrition in the developing world through the increased production and consumption of nutritious, health-promoting vegetables.

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