AVRDC
The World Vegetable Center

ANNUAL REPORT 2014

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AVRDC - The World Vegetable Center

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AVRDC – The World Vegetable Center
P.O. Box 42 Shanhua, Tainan 74199
Taiwan
T +886 6 583 7801
F +886 6 583 0009
E info@worldveg.org

avrdc.org

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Editor: Maureen Mecozzi
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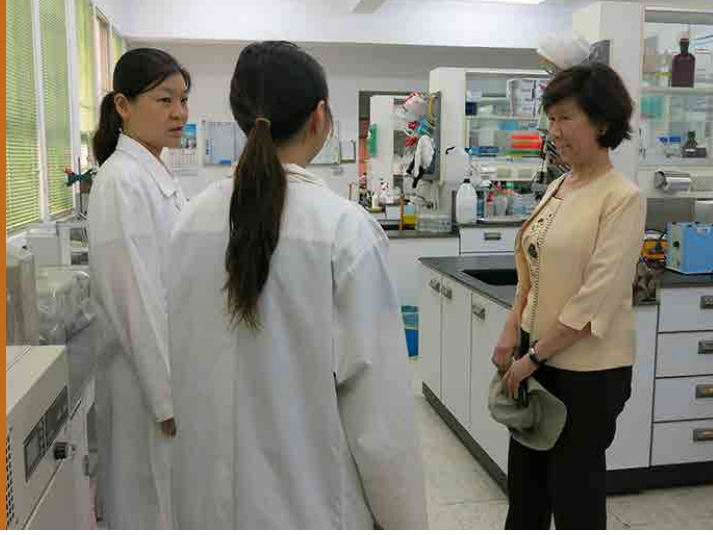

The 8th External Program and Management Review

Prompted by the report of its 7th External Program and Management Review (EPMR), in 2008 AVRDC rebranded itself to become AVRDC - The World Vegetable Center. In 2014, the Board of Directors requested the Center's management to commission another external review. The 8th EPMR Report (January 2015) is the fruit of this labor.

An effective EPMR is a requirement to be undertaken regularly in institutions that aspire to good governance. Following the Board of Directors' recommendation, and in line with good governance practices, the Center agreed for the first time to include board activities within the purview of the external review.

The board Executive Committee selected three candidates from a competitive list that were approved by the full board to form the EPMR Panel. They were Dr. Douglas Pachico (*below right*) Agricultural Economist, Consultant Ex-International Center for Tropical Agriculture (CIAT), Professor Lucy Sun-Huang (*above right*), Nutritionist, National Taiwan University, and Professor Philip Harris (*next page, left*), Plant Scientist, University of Coventry, UK. Dr. Pachico proved to be a strong choice as panel chair. He demonstrated his organizational skills, vitality and stamina starting with his attendance as an observer at the Center's April 2014 Board of Directors Meeting in Arusha, Tanzania. He then visited AVRDC Eastern and Southern Africa and its partners in the following week, accompanied by the Regional Director and the Director General. Visits to other regions were made in May 2014 to AVRDC East and Southeast Asia in Bangkok, Thailand by Prof. Sun-Huang; to AVRDC West and Central Africa in Bamako, Mali by Prof. Harris; and to AVRDC South Asia in Hyderabad, India by Dr. Pachico and Prof. Sun-Huang, accompanied by AVRDC's Deputy Director General for Administration and Services.

The full EPMR panel was invited to the Center's headquarters in Shanhua, Taiwan for a three-week period beginning in early November 2014. Panel members interviewed a full range of staff and research teams, and also attended planning and reporting presentations by headquarters and regional staff during the Center's annual institutional planning meetings. This process culminated in the November 2014 Board Executive Committee meeting, at which the panel presented its findings. The panel members indicated their general satisfaction with the Center's activities over the last seven years and made a series of forward-looking recommendations and suggestions. Dr. Pachico also visited the Council of Agriculture of the Executive Yuan of the Government of the Republic of China and the Ministry of Foreign

Affairs in the days immediately after the Executive Committee meeting. In parallel, members of the Center's Research and Development Committee, Institutional Management Committee, and other senior international staff discussed the panel's report to consider the possible implications of the recommendations and suggestions. The overall conclusion by the Center was satisfaction from such a positive report. Although the recommendations could be beneficial in many instances, approval of the Board of Directors will be needed before any proposed changes are made.

The timing of implementation of the EPMR recommendations will continue to be discussed internally. For the critical strategic recommendations, however, further time will be required for effective gestation because, in October 2015, the Board of Directors will make an additional crucial decision for the future of the Center by selecting a new Director General. My second full term as Director General will end in April 2016. It therefore makes sense for the Center to seek the Board of Directors' input and the new Director General's participation in deciding on any significant EPMR-prompted actions from late 2015 onwards. The timing of the EPMR report was planned specifically to allow this orderly transfer of leadership to be guided appropriately.

I am pleased to say the EPMR panel members expressed considerable appreciation for the smooth logistics and highly positive human interactions throughout the whole exercise. I derived much satisfaction from the highly professional performance of all AVRDC staff during the period of this demanding exercise. One action that the panel and staff much appreciated was the creation by the Board in 2014 of a new competitive scientific Innovations Fund. Budget surpluses in 2012 and 2013 allowed sufficient reserve capital to be accrued for the purposes of guarding the Center against foreseeable future business uncertainties. Additional budget surpluses are now to be made available not only to cover the usual infrastructural construction, maintenance and equipment expenditures, but also to support innovative scientific research. It is hoped this mechanism will prompt the Center's research program to produce additional significant upstream international public research goods.

We live in an era of ever-increasing abiotic and biotic pressures, of climate uncertainty, and of increasing human population demands on vegetable production. In response to these research pressures and the development demands of the new UN Sustainable Development Goal 2, AVRDC – The World Vegetable Center will continue to renew itself and its scientific and development program. We are determined to live up to the Center's 40-year-old mandate as the world's leading research and development center for tropical and subtropical vegetables helping to eradicate malnutrition and bring prosperity to the poor and health for all.

J.D.H. Keatinge

OFFICES

1. AVRDC - The World Vegetable Center, Headquarters - Taiwan
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5. Project Office - Sigatoka, Fiji
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16. Project Office - Sikasso, Mali
17. Project Office - Maroua, Cameroon

IN FOCUS

The GENEBANK

A COOL RECEPTION

Ensuring the Center's diverse bitter gourd collection (currently at 462 accessions) remains viable is the job of seed curator **Yung-Kuang Huang** (*below right*). "Storing bitter gourd seed at sub-zero temperatures damages the seed," Yung-Kuang said.

"Germination rates plunge to less than 5%—that's not acceptable." Yung-Kuang and his colleagues in the Genetic Resources and Seed Unit dried bitter gourd seed of two accessions (one from India, the other from Thailand) to a 6% moisture content. Seed of each accession was split into three batches (B1: no treatment; B2: stored at 15 °C for six months; B3: stored at 5 °C for six months). They then applied six different priming treatments: no treatment; soaking in water for 24 hours; removing part of the seed coat and soaking in water for 24 hours; soaking in rice vinegar; soaking in a 0.3% potassium nitrate solution for 1 hour; and soaking in water for 24 hours followed by drying in a dehumidified chamber for 72 hours. After six months of storage, the germination rates of seed stored at 5 °C improved by 45-86%. The simple seed priming treatments, designed for farmers' ease of use, further enhanced germination rates. "This technique will help overcome seed dormancy and seedhardedness of bitter gourd, ensuring safe long-term storage and good germination rates when the seed is withdrawn from storage for production," said Yung-Huang.

THE BACK-UP PLAN

When you have something precious, you take steps to ensure its safety. When you have something valuable, you secure it. The AVRDC Genebank—the world's largest public collection of vegetable seed—backs up its collection at several locations, notably the National Agrobiodiversity Center (NAC-RDA) of the Rural Development Administration, Korea; the Taiwan Agricultural Research Institute (TARI); and the Svalbard Global Seed Vault, Norway. "AVRDC has had an agreement with RDA since 2008 for storing parts of our collection," said **Andreas Ebert**, Genebank Manager. "Today about 21.4% of our genebank holdings are duplicated there." TARI also safeguards a significant portion (40%) of the AVRDC collection. The Svalbard vault, meant to store seed to regenerate agriculture in the event of a global catastrophe or restore genebank collections destroyed by strife or natural disasters, contains more than 830,000 samples originating from almost every country in the world. "14,411 of those samples are AVRDC's," Andreas said. "That's about 23% of our collection." The most recent shipment of 1642 accessions made the trek to Svalbard (the farthest north a person—or seed—can fly on a scheduled flight) on 1 October 2014.

ON THE LIST

Individuals in a crowd: How to find them? "That's our task—to help users worldwide locate the 61,280 accessions in the AVRDC Genebank," said **Sophie Chou**, Principal Research Assistant. The AVRDC Vegetable Genetic Resources Information System (AVGRIS) database is where Sophie and her colleagues input details for each accession in the collection. Descriptions include *passport* (site collected, date, latitude, longitude, useful information from donors of the germplasm, etc.) *characterization* (traits that can be easily measured and described by the eye, from the seedling, vegetative, flowering, fruiting and final seed extraction stages, such as leaf shape, flower color, fruit shape, etc.) and *evaluation* (traits that are influenced by the environment, such as reaction to pests and diseases, etc.) data. This year the team prepared 4457 descriptions for the database, but it's a never-ending job, as accessions that are regenerated must be re-described. The careful observations and precise descriptions made by genebank curators ensure plant breeders and others who are interested in the Center's germplasm collection can find *exactly* what they are looking for. Visit AVGRIS at http://avgris.worldveg.org/

NO MORE BLACK ON RED

Tomatoes grown in humid conditions often are attacked by the fungus *Pseudocercospora fuliginea*, which causes black leaf mold, a common but destructive disease. "For small-scale farmers, the best method to control black leaf mold is planting resistant cultivars," said **Fang-I Ho** (*above*), Assistant Specialist – Bacteriology. AVRDC's Plant Pathology team developed a screening method to spray mycelium (segments of the fungus tissue) at various concentrations to identify tomato lines with resistance to black mold. The method efficiently distinguished resistant and susceptible plants. Through further analysis of 480 tomato plants of line CLN3868, the team also found four molecular markers that can be used to identify plants with black leaf mold resistance. These markers, especially one called SLM1-60, will help breeders select populations to develop resistant tomato cultivars.

ON THE MARK

"It's a little like finding a needle in a haystack" said **Roland Schafleitner**, Head of Molecular Genetics and the leader of AVRDC's effort to identify molecular markers to pinpoint specific variations in DNA that are associated with important plant characteristics. Among their many activities in 2014, Roland, together with the AVRDC Virology team, developed genetic markers to identify resistance genes to virus diseases in *Cucurbita moschata* (squash and pumpkin). In tomato, resistance to tomato yellow leaf curl disease, late blight and nematodes has been bred into production lines from wild tomato species; using large samples, AVRDC researchers validated the markers—ensured the association was real—by examining whether the markers correctly predicted resistance or susceptibility in other populations independent of the original discovery population. Flexible assays (testing procedures) to evaluate multiple resistance genes at a time have been developed for breeders to select disease resistant tomato plants. Genetic mapping in pepper (a big task, as the *Capsicum annuum* genome contains more than 3 *billion* base pairs, with many repeat sequences) was made more efficient by using high throughput sequencing approaches, which yielded more than 7000 markers.

PLANTING THE SEED

"Conservation of global biodiversity depends on the skill of the next generation," said **Andreas Ebert** (*below*), Genebank Manager. "We have to pass on what we have learned to ensure continuity for the future." That's why, in 2014, Andreas conducted three training courses in Laos, Cambodia, and Indonesia on community seed bank management and seed production. He guided two visiting scientists from Korea's National Institute of Horticultural & Herbal Science and National Agrobiodiversity Center, six summer scholars from Chung Hsun University, Chinese Culture University and National Chiayi University, and one research fellow from the Taiwan Agricultural Research Institute in safe germplasm management and the use of morphological tools for biodiversity analysis. Plus he taught a session on seed production systems to 29 participants during Module I of the 33rd International Vegetable Training Course in Thailand. Now that's what you call dissemination.

West and Central Africa

West and Central Africa is home to about 300 million people, many of whom are smallholder farmers growing a variety of staple food crops within complex farming systems where livestock, tree crops, and vegetables cohabit in various spatial and temporal configurations. Vegetables dominate off-season production, are mainly grown on small plots and traded by women, and account for an estimated 40% of the market sales of products in the region. Thus, AVRDC - The World Vegetable Center aims to catalyze increased and sustained growth in this sector, which will translate into more income for women and associated benefits on household food and nutritional security, health and educational status of children. These changes will occur concurrently in many countries.

AVRDC West and Central Africa started the year with two full-time scientists and ended with an increased competency pool of experienced professionals in plant breeding (2), cropping systems agronomy (2), food science and nutrition (1), socioeconomics (1) and project development (1). This will enable the Center to meet existing commitments and respond to emerging opportunities in the region. As it aimed to attain its own critical mass, the regional office concurrently continued to contribute to capacity building of national agricultural research systems (NARS) in the region through support to the Ghana-based West Africa Centre For Crop Improvement (WACCI, an initiative of AGRA, the Alliance for a Green Revolution in Africa) and thesis research support to graduate training. We supported the research of four masters' students, two from the University of Ouagadougou (Burkina Faso), one from the University of Development Studies (Ghana) and one from the University of Douala (Cameroon).

The regional office concluded a three-year assessment of the feasibility of carrying out global onion breeding activities from Mali, following the transfer of the program from Taiwan. Substantial investments have been made to develop ambient and cold storage facilities for bulbs and seeds. Obtaining seed had been the main challenge faced in Taiwan. The transfer to Mali did not overcome this constraint, particularly for lines that had not been developed in the region. Thus, additional efforts have been directed at developing cold treatment protocols to enhance seed set. Preliminary results indicate that subjecting mother bulbs to cold treatment of 10 °C for four weeks appears to trigger floral initiation in several lines from Taiwan, opening possibilities for use of exotic lines in cross-breeding in the region. Another crop of major focus for the region is okra, which the Center sought to establish breeding capacity for in Cameroon. In particular, non-sensory protocols using viscosity were developed and used to screen breeding populations for mucilage content, which is a major quality trait sought after in the region.

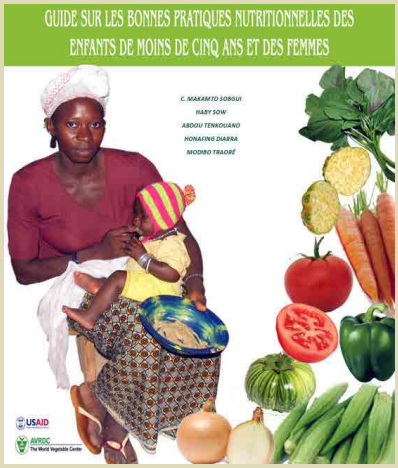
Meanwhile, the Center continued to nurture partnerships with NARS and nongovernmental organizations (NGOs) to address issues surrounding mass supply of vegetables based on efficient seed production and delivery systems,

promoting diet-diversifying and nutrition-enhancing use of vegetables, and linking producers to markets through demonstration and training interventions taking place in best practice hubs (BPH). As land, water and labor become scarcer, the Center has invested in promoting intensively managed small plots within organized communities, based on a formative testing and demonstration model that allows growers to access improved technologies while enabling research to maintain credibility, relevance and a strong, client-oriented focus. In a recently concluded three-year pilot of this approach in southern Mali with support from the United States Agency for International Development (USAID)-Mali, the Center developed more than 50 locally adapted improved vegetable varieties, a quarter of which appeared to meet growers expectations. An independent end-line study carried out by the Institut d'Economie Rurale (IER) reported that around 2500 vegetable growers have been direct beneficiaries of this work, with about 90% initial adoption rate. It is estimated, conservatively, that there are at least 20 times more indirect beneficiaries as a result of open field days and associated mass communication activities. The area of land where these technologies are applied increased from 4 hectares in 2011 to 180 hectares in 2014. Additionally, the capacity of 55 private enterprises, farmers' and women's groups was reinforced with new technologies and management skills with an application rate of 87%.

Nutrition guidelines were developed in partnership with the Malian Ministry of Health and used for community nutrition interventions across southern Mali. The Center and partners trained 592 women and 244 men in vegetable production technologies for establishing home gardens rich in nutritious vegetables, and more than 3000 seed kits of okra, tomato, African eggplant, pepper and amaranth seeds were produced and distributed. Training in nutrition and feeding practices for babies and women informed 892 women and 382 men, and another 276 women and 122 men were trained in postharvest technologies and food processing. The Center has now embarked on scaling out these achievements within southern Mali and to northern regions of Mali.

The Center supported an scaling-out initiative sponsored by the International Fund for Agricultural Development (IFAD) through the *Projet D'Appui au Développement des Filières Agricoles* (PADFA, Commodity Value Chain Development Support Project) in northern Cameroon that is entering the third year of its four-year lifetime ending in 2016. For the project, the Center produced 30.5 kilograms of onion seeds and 1.5 tonnes (t) of mother bulbs of the local landrace Goudami, which was the best among a set of eight tested varieties. With improved nursery and production practices, yields of 20-40 tonnes per hectare (t/ha)—well above the country average of about 8 t/ha—were recorded by farmers engaged in the project, and these practices were demonstrated to 411 more onion farmers (214 male, 197 female) through field days.

The Center moved into the implementation phase of a three-year project for increased production and marketing of traditional leafy vegetables, with partners from Burkina Faso, Cameroon and Ghana and support from the West and Central Africa Council for Agricultural Research and Development's (CORAF) multi-donor trust fund led by the World Bank. Essential achievements in 2014 include the publication of a book on traditional Cameroonian vegetable recipes that have been passed on from generation to generation. Also, more than 100 kilograms of seeds of ten vegetable species (three varieties of nightshade, one of amaranth, four of jute mallow, one of African eggplant and one of okra) from AVRDC were produced and distributed to 1000 farmers in targeted countries, with each farmer currently cultivating at least two of the new varieties.



COOKING FOR HEALTH: Preparing family meals for maximum nutritional benefit takes knowledge and skill. That's why Project Manager **Caroline Sobgui** and Research Assistant **Honafing Diarra** worked with Mali's Ministry of Health to design nutrition training modules for field assistants who offer instruction to women on healthy food preparation for their families. "We produced a colorful illustrated food guide for mothers that features recipes for traditional vegetables," Caroline said. "It has information about what kinds of foods are best for children at specific ages." For instance, the guide explains how to prepare good-tasting and nutritious vegetable purees suitable for feeding children under five years of age. In Cameroon, Research Associate **Regine Kamga** and colleagues compiled tasty traditional vegetable recipes from around the country to increase consumption of these nutritious crops in schools and homes.

SEEDS OF LIFE: Oumou Djeneba Yalkoï from Kuoro Barrage, Sikasso district (Mali) planted a home garden after she received training on nutrition and vegetable production along with a seed kit from AVRDC. Now she is harvesting amaranth leaves and okra, and incorporating vegetables into family meals. Oumou was pregnant when she received the seed kit. After her child was born, she had the fresh ingredients at hand to prepare nutritious food for herself and the baby.

FEWER PLANTS YIELD MORE: "Everybody loves *boulanboulan* (amaranth)," said **Mrs. Sara Sawadogo**. "So it is grown by most gardeners in our area (near Gampela, Burkina Faso)." Farmers previously harvested amaranth (37.5 m^2) four to five times before replanting and sold each harvest at 2,500 FCFA (US$5.32); Sara is selling at 3000 FCFA ($6.38) per harvest because of the improved production techniques she applies. "When the technician proposed to reduce the planting density, all the farmers refused because it is against normal practice: we usually broadcast, just as in the nursery," she said. "I volunteered to try his proposition. Now, when you look around, I am the best; my plants are much more verdant. Everyone now regrets to have refused to be part of the trial. We did not know that fewer plants yield more."

A NEW CAREER: Paul Mballa from Cameroon, 33 years old, holds a BSc in sociology. He has been unemployed for the past eight years, and was looking for a way to generate income. "I attended a farmer's day organized by Cameroon Agenda for Sustainable Development (CASD), a project partner in AVRDC's Traditional African Vegetable initiative, on June 25, 2014 in Ebolowa and got interested in traditional African vegetable production," he said. Paul began growing amaranth, African nightshade and jute mallow on a 1000 m^2 farm and soon found buyers for his produce. "With the new source of income, I expanded my farm to 3000 m^2, and I registered to write the entrance examination into the Technical School of Agriculture, which I passed," he said The income he receives from selling traditional vegetables will enable Paul to continue his studies and take care of his family.

Eastern and Southern Africa

At the beginning of 2014, AVRDC Eastern and Southern Africa underwent a thorough renovation. The refurbishment, combined with an awareness campaign, attracted partners to use the field, training and laboratory facilities. During the course of the year, AVRDC Eastern and Southern Africa hosted several high-profile events, such as the Annual Board of Directors' meeting (April 2014), the 4th Agri-business Finance Fair organized by the Tanzania Horticultural Association (April 2014), a delegation of Ministers of Agriculture from seven countries (September 2014), the Annual Meeting of genebank managers under the Global Crop Diversity Trust (October 2014), and Tanzania's first course on Plant Breeders' Rights under the umbrella of UPOV, the International Union for the Protection of New Varieties of Plants (December 2014).

AVRDC Eastern and Southern Africa holds the largest seed repository of vegetables on the continent, comprising 2592 accessions and ~50 species, mainly focusing on traditional vegetables. To protect this valuable collection, in 2014 the physical facilities were upgraded (e.g. better temperature control), and improved seed drying procedures instituted to bring moisture content in line with international standards for longer term conservation. The seed repository distributed 732 accessions to universities, research organization and private companies. Through its partners, the seed repository also distributed 1431 seed kits to smallholder farmers. These seed kits allow poor and vulnerable communities to increase their nutritional status while generating income. Seed kit distribution went hand-in-hand with practical and comprehensive training-of-trainers programs and follow-up visits in the field. Through 'VegOneX', the regional office is pioneering ICT systems for enhancing the seed supply system and for creating vegetable supply analytics. At the end of 2014, the regional office kick-started the large USAID-funded project 'Deploying vegetable seed kits to tackle malnutrition', aimed at scaling diet-enhancing vegetable home garden seed kits in a sustainable way in Kenya, Uganda and Tanzania.

Needs assessments of postharvest handling and storage for vegetable crops in Ethiopia and Malawi were conducted in 2014, as were evaluations of shelf-life performance of newly introduced vegetable varieties in Malawi; assessments of pesticide application practices by smallholder vegetable producers in Tanzania; and testing zero energy cool chamber (ZECC) evaporative coolers for short-term storage of vegetables in Malawi. These field activities were complemented with on-station research in Tanzania on options to reduce deterioration of vegetables during storage, transportation and marketing (e.g. through use of icepacks, low cost hydro-coolers and improved packing crates); and capacity-building interventions in Kenya and Tanzania to ensure better understanding of postharvest opportunities to add value, minimize losses and improve nutrition.

One of the region's largest projects, 'Improving income and nutrition in Eastern and Southern Africa by enhancing vegetable-based farming and food systems in peri-urban corridors' (VINESA), funded by the Australian Center for International Agricultural Research, began in early 2014. This project concentrates on enhancing the vegetable production and marketing skills of young farmers, and emphasizes a value chain perspective. Four best practice hubs have been established in the target countries (Ethiopia, Malawi, Mozambique and Tanzania), and 160 young farmers have graduated.

Africa RISING brings integrated, innovative solutions to smallholder farmers using a systems approach, and achieved great results in 2014 by introducing new varieties of traditional African vegetables and increasing good agricultural practices. The project expanded in size and geographic scope by including two grassroots organizations (Nafaka and Tuboreshe Chakula). The regional office also made great progress adding vegetables in integrated farming systems under the Humidtropics program, implemented by the International Institute of Tropical Agriculture.

AVRDC Eastern and Southern Africa's office currently employs nine internationally recruited staff, 22 nationally recruited staff, five consultants and one person seconded from the Ministry of Agriculture, Food Security and Cooperatives. The regional office is also expanding geographically, with a liaison office opened in Uganda, and soon in Kenya.

TESTING TOMATO IN TANZANIA: An important aspect of the Center's breeding work is to ensure its vegetable lines are well adapted to local climates and conditions. **Fekadu Dinssa**, Vegetable Breeder at AVRDC Eastern and Southern Africa in Arusha, Tanzania is in regular contact with local farmers; he knows the kinds of challenges they encounter in the field. "Diseases are a big problem, and smallholders often lack the know-how and the products for safe control," he said. "Building resistance into the plant is the best solution to help vegetable growers." Fekadu planted 15 tomato lines from AVRDC headquarters with different combinations of resistance to bacterial wilt, late blight, and tomato yellow leaf curl disease in the Arusha experimental fields. He tracked characteristics such as days to maturity, marketable yield, brix value (sugar content), and fruit length and width. "Five lines produced significantly higher marketable yields than the control lines," Fekadu said. "That's the kind of performance farmers like to see." The lines will undergo further testing to ensure their good qualities will hold up.

ONE, TWO, THREE: "Amaranth is a versatile vegetable that every farmer should try," says Vegetable Breeder **Fekadu Dinssa (***above right***)**. "The leaves are a crop. The grain is a crop. And there are varieties that are dual-purpose—they can be grown for the leaves and for the grain." In Africa amaranth is mostly grown for its nutritious leaves, but the light-colored tiny grains of the crop are also becoming popular in Kenya and other countries, and farmers are seeking amaranth that can do double duty. Fekadu identified one leafy type, two grain types and three dual-purpose amaranth lines based on two seasons of evaluation in Arusha, Tanzania. Stems and leaves of the dual-purpose cultivars can be harvested multiple times while allowing the plant to set grain. The lines are being recommended to national agricultural agencies and seed companies for further evaluation. Customers for improved amaranth include **Mrs. Ephraim Lukumay**, a farmer in Bermi village, Dareda ward, Babati District of Tanzania, who didn't think too highly of the crop a few years ago. "We did not know the nutritive importance of this vegetable," she said. "And we did not have good quality seeds." Today she grows amaranth to consume at home and to sell to neighbors and at markets. She is a participant in USAID's Africa RISING East and Southern Africa Project, an initiative to improve agricultural production knowledge and access to high performing vegetable varieties in the region. As part of the project, Mrs. Lukumay and 70 other farmers learned good production practices and farm record-keeping skills during training sessions hosted by AVRDC Eastern and Southern Africa. "The AVRDC variety is fast-growing, tastes good, and is very nutritious," said Mrs. Lukumay. "I sell about 10 kilograms a week. Most of my customers are pregnant mothers and families with children under five. When they visit pre-natal clinics, the nurses tell them to eat more amaranth!"

FORGING LINKS IN THE VALUE CHAIN: Finding opportunities for farmers to fully engage in markets requires knowledge that can only be obtained on the ground through surveys and stakeholder discussions. AVRDC researchers actively solicit the opinions and perspectives of farmers, input providers, collectors, wholesalers, retailers and customers to develop sound programs and policy recommendations. "The ACIAR-funded VINESA project in Ethiopia, Tanzania, Malawi and Mozambique aims to address knowledge gaps along the value chain, and we've created hubs to serve as centers for learning, crop trials and experiments," said **John Macharia**, VINESA Project Manager. "We encourage value chain thinking among all participants, and as they work together, we are starting to see results." In 2014 the project trained 160 young people to take up farming as entrepreneurs; 69 staff from research and extension institutions in the four countries received training to continue the VINESA approach after the project ends. In Pakistan, the Agricultural Innovation Program funded by USAID aims to strengthen linkages and relationships among value chain actors such as farmers, wholesalers and retailers. "Farmers want to see robust market demand for their produce before they take a chance on a new crop," said **Mansab Ali**, Vegetable Program Leader. "So we promote crops such as mungbean and vegetable soybean at large agricultural fairs, where many people will have the opportunity to learn about them, how they are grown, how they are prepared. They ask questions… and soon enough start looking for these products at the market. We also work with staff from agricultural ministries and the private sector to make sure quality seeds, appropriate equipment, and optimal and safer production methods are available for farmers."

POSTHARVEST PRACTICES: In some countries, more than a third of the vegetable harvest can be lost from field to market. Finding appropriate handling methods and tools to reduce losses and improve the physical and nutritional quality of vegetables is the task of Postharvest Specialist **Ngoni Nenguwo** in Africa. "For tomato, we tested the value of lining wooden packing crates with paper or sacking, and found they reduced damage to the fruit by 6%," he said. "The paper lining can increase profits by 3%." Ngoni is evaluating optimum treatment levels for chlorinating washing water for vegetables in Tanzania, and the use of brick-and-sand evaporative coolers for short-term crop storage in Ghana, Kenya and Tanzania in collaboration with several national universities.

SEEDING PARTNERSHIPS: Multiplication is more than just arithmetic for AVRDC Eastern and Southern Africa Genetic Resources Scientist **Tsvetelina Stoilova**; it is how she is able to increase opportunities and improve the livelihoods of people in Africa. "In 2014 we grew, collected, processed and packaged seed of up to 12 vegetable crops for inclusion in 1341 seed kits," she said. Those kits were distributed by Center partners—Helen Keller International, CABI, OIKOS, the Humidtropics program in Uganda, and Africa RISING in Babati, Tanzania—during workshops and training courses, and to a school and an orphanage. "Beneficiaries of these organizations now have seed, the essential element to produce nutritious vegetable crops near home to enrich family diets," said Tsvetelina. She also produced about 40 kg of seed of 712 accessions of 13 vegetable crops, which went to the public sector (21.4 kg; universities, research institutes) and private seed companies (1.1. kg) for further study and commercial use in nine African countries. A significant amount of seed (16.6 kg) was used in-house.

IN CONTROL: Plant activators—treatments that induce defense responses in plants, and thus prevent or slow infection from pathogens—can be effective components of an integrated crop management package. For two years, Mycology Assistant Specialist **Wallace Chen** and colleagues have been assessing the efficacy of four plant activators for disease control on tomato and peppers. "For broad-spectrum applications, we found that solutions of neutralized phosphorous acid, BION™ and ReZist™ produced the best results, especially against tomato late blight, tomato southern blight, and pepper Phythophthora blight," he said. Tomato grown in a peat-based potting mixture containing 5% biochar (charcoal made from agricultural residues) and biocontrol agent *Streptomyces* showed enhanced resistance to early blight; the results may indicate a synergistic effect between the biochar and the biocontrol agent.

East and Southeast Asia

AVRDC East and Southeast Asia celebrated its 33rd anniversary following its establishment in 1982 as the first regional center outside of Taiwan and the assignment by The Royal Thai Government of Kasetsart University (KU) as our official collaborator.

Improved lines and varieties were evaluated for suitability to growing conditions and consumer preferences, and various pest and disease management technologies were tested across the region. The global crop improvement program for cucurbits, in particular bitter gourd (*Momordica charantia*) and pumpkin (*Cucurbita moschata*), has been operational for five years, and in 2014 gained recognition from seed companies and public sector breeding programs. Lines with desired traits, such as fruit shape, size and taste, resistance/tolerance to abiotic and biotic stresses, and with favored agronomic characteristics such as time from planting to maturity were bred and tested in Cambodia, Lao PDR, Vietnam and Tanzania.

Capacity building has been a respected and visible function of the East and Southeast Asia regional office. In 2014 the 33rd International Vegetable Training Course (IVTC) was held to serve the training needs of other AVRDC regions and several different research for development projects. The three-month course provides a unique opportunity for international trainees to share their diverse expertise and experiences. The IVTC harnesses resource experts from AVRDC (both current and past staff), international experts from several universities, plus national collaborators from KU, Mahidol University for nutrition, Department of Agriculture for extension, and seed companies and other private enterprises representing key components of vegetable value webs. The course is deemed academically credible as demonstrated by the signing of trainee certificates by the Vice President of KU, in addition to AVRDC.

Capacity was further increased through 14 in-country training courses to address needs identified by Cambodia, Indonesia, Lao PDR and Myanmar as part of the SATNET Asia project (Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia) coordinated by the Economic and Social Commission for Asia and the Pacific of the United Nations (UN-ESCAP), and funded by European Union (EU).

PARTNERSHIPS BEAR BETTER BITTER FRUIT: Bitter gourd (*Momordica charantia*) has engaged the best efforts of Cucurbit Breeder **Narinder Dhillon** for several years. "Bitter gourd has compounds that can help diabetics control their blood sugar levels," he said. "It's an important crop that should be grown in more places." To help introduce bitter gourd to a wider audience, Narinder and his team carried out trials of eight advanced bitter gourd lines at AVRDC's East and Southeast Asia Research and Training Station in Kamphaeng Saen, Thailand, and also with partners the Bangladesh Agricultural Research Institute in Gazipur, and the Sakata Seed Company's Bangalore Seed Farm in India. In all three locations the lines were assessed for marketable yield, number of fruits produced, fruit weight, color, bitterness and skin pattern. Seed of the top-ranking lines was multiplied and distributed to 12 seed companies in Asia for use in their breeding programs. The seed was also distributed to farmers in Arusha, Tanzania by researchers from AVRDC Eastern and Southern Africa.

NAMING NEW MEMBERS OF THE FAMILY: The Luteoviridae, a family of plant viruses, may have expanded their number by three thanks to the detective work of Virologist **Lawrence Kenyon** and his team. By assessing the molecular diversity of plants with virus-like symptoms collected from cucurbit fields in Mali, the Philippines, Thailand and Uzbekistan, the researchers identified six distinct virus species, including two new polerovirus species for which the names Pepo aphid-borne yellows virus (from Mali) and Luffa aphid-borne yellows virus (from Thailand) were proposed. The team also sequenced the genome of a virus collected from samples of *Sauropus androgynous* (*right*) obtained in Thailand and found it represented a new species of polerovirus, which they have suggested calling Sauropus yellowing virus. "We need to be aware of emerging virus diseases in target vegetable crops," said Lawrence. "We can then develop appropriate and effective control measures. Plus, we have the chance to name our adversaries!"

SWEETER CMS: Cytoplasmic male sterility (CMS) is a method used to produce hybrid seed of hot pepper (*Capsicum annuum*) because it can reduce production costs for pollination by almost half. Its use in sweet pepper breeding has been limited, however, because of the lack of good CMS-restorer lines to serve as pollen parents, and because CMS-sterile lines show poor stability under low temperatures. Ideally CMS-sterile parents must be stable under all environmental conditions if they are to be relied on to generate hybrid seed of high purity. Using marker-assisted backcrossing, Pepper Breeder **Sanjeet Kumar** and his team developed sweet pepper restorer lines and confirmed the fertility restoration ability of these lines. "These new restorer lines have great potential for making CMS hybrid technology a real possibility for sweet pepper," he said. "And that means sweet pepper producers may finally be able to enjoy some of the same cost reductions when producing hybrid seeds that hot pepper growers have realized for some years."

FOOLING A FUNGUS: Late blight on tomato causes big problems for farmers in the cool, wet highlands of Bali. The culprit is *Phytophthora infestans*, a fungus-like pathogen that can quickly defoliate plants and create lesions on fruit that lead to rot. Field experiments using applications of neutralized phosphorous acid salt (NPS), a biopesticide, proved to be as effective as conventional fungicides to control the disease. "The great thing about NPS is that it's much cheaper than commercial fungicides, and easier on the environment," said **Putu Sudiata**, AVRDC project partner at Udayana University in Bali. "It's a viable and cost-effective plant protection alternative for farmers."

BIG ON BROCCOLI: This often-maligned vegetable needs an image makeover, and **Ruby Hsiao** from AVRDC's Breeding Team is just the person to bring broccoli the credit it deserves. Compounds in this crucifer can help alleviate arthritis, protect blood vessels in the heart, and reduce certain cancers. Consuming just 100 grams of broccoli provides more than 150% of the recommended daily intake of vitamin C. "Broccoli is typically a cool-weather crop, but we've developed some heat-tolerant types that may prove useful for farmers in warmer locations," Ruby said. From field trials in 2013, she selected six new hybrids. The parents of each hybrid were grown inside net houses and pollinated with the help of honey bees. The seed collected will be used for international distribution and testing.

South Asia

Pakistan became the new focus of AVRDC activities in South Asia in 2014 and postharvest handling of vegetables a new area of training and research. Regional research facilities and capabilities were upgraded, stronger relationships were developed with regional partners, and good progress was made in legume breeding.

The Agricultural Innovations Program (AIP) is now the largest AVRDC project in the region and the largest AVRDC project worldwide. The project has components in both Pakistan and India. With a focus on protected cultivation, improving mungbean production, and strengthening value chains, the United States Agency for International Development (USAID)-funded project builds on previous AVRDC work in the region. AVRDC's component is a part of an integrated program led by the International Maize and Wheat Improvement Center (CIMMYT), in partnership with the International Livestock Research Institute (ILRI), the International Rice Research Institute (IRRI), the University of California – Davis, and the Pakistan Agricultural Research Council. During the year, 16 new staff were appointed in Pakistan and three in India, expanding regional expertise in socioeconomics, agricultural engineering, legume breeding, and seed production.

Because of travel restrictions, scientists from Pakistan and India rarely visit each other despite sharing common cropping systems and agroecological zones. The project is helping to expand scientific cooperation. Scientists from Pakistan visited Punjab Agricultural University in India to develop joint R&D in protected cultivation and mungbean production, building on extensive and complementary work in both countries. The Pakistan team has interacted extensively with other AVRDC project partners in Bangladesh to learn from their experiences in protected cultivation of tomatoes during the rainy season, and Indian project partners have joined in training activities with their AVRDC colleagues in Bangladesh.

The region developed a new focus in postharvest management of vegetables with the appointment of Jun Acedo to lead the Asian component of the USAID postharvest project in Bangladesh, Nepal, and Cambodia. Surveys of postharvest losses were begun, and training programs held for regional partners. Postharvest losses of vegetables range from 24% to 48% and AVRDC is building good connections with national partners to target the best means of reducing these losses.

The postharvest work has expanded AVRDC's involvement in Nepal, where project work on the promotion of school vegetable gardening was already underway, funded by the Swiss Agency for Development and Cooperation (SDC) with the support of the Ministries of Agriculture, Health and Education. Similar AVRDC work is continuing in Bhutan.

A growing rural labor shortage across India and in other parts of South Asia is forcing farmers to rethink how they manage crop weeding and harvesting. New approaches to mechanization are needed. AVRDC in Pakistan is researching better ways to mechanically harvest mungbean, and new approaches to weed control and irrigation are being implemented at AVRDC South Asia in Hyderabad. The research fields are being shifted over to complete use of plastic mulching and trickle irrigation to reduce weeding and water use. Experiments are being expanded to find the most suitable types of polynet houses for protected cultivation of vegetables.

New partnerships are being built with the public and private sectors across the region. A full national agreement was finalized with the government of Bangladesh to support the work of AVRDC, and a technical cooperation agreement with the Pakistan Agricultural Research Council was signed. The Indian seed sector has been a long-term supporter of AVRDC and a beneficiary of the Center's improved vegetable lines. A new project funded by 22 Indian seed companies to test the local performance of AVRDC tomato lines carrying various combinations of genes conferring resistance to *Tomato yellow leaf curl virus* has begun.

AVRDC's legume breeding program is based in the region and a major focus of its work is developing mungbean lines that are resistant to mungbean yellow mosaic disease, caused by a begomovirus. India is the world's largest producer of mungbean; the disease can completely destroy crops, and is rapidly spreading across the region and beyond. Breeding work continues to make good progress in addressing control of powdery mildew in mungbean, improving the crop's resistance to bruchids that damage stored seed, and improving the food value of the crop by improving its methionine content and the quality of its protein.

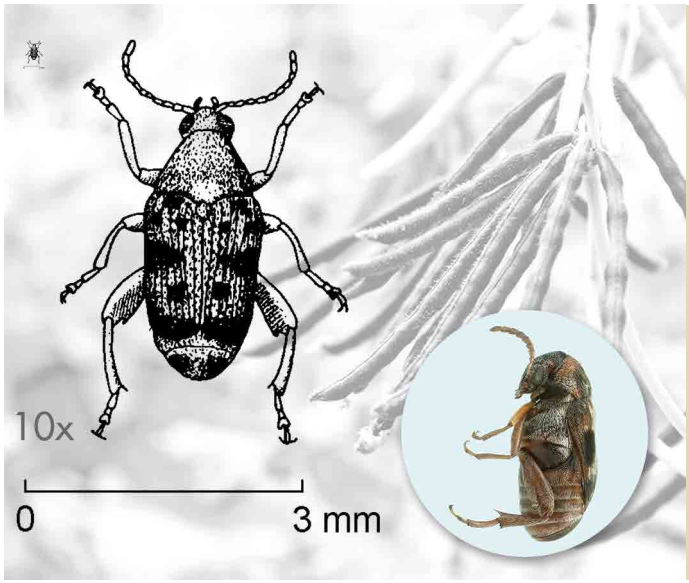
MUNGBEAN MAGIC: Say the name "NM11" in Pakistan and farmers are likely to smile: With its short time to maturity (65-75 days), this variety has found a place as a catch crop between rice-wheat rotations, producing additional profit for growers of up to USD 875 per hectare and enriching the soil with nitrogen. Intercropping of mungbean with sugarcane has produced bean yields of up to 437 kilograms per hectare, and brought in additional profits of up to USD 377/ha. Double cropping mungbean after rain-fed wheat has yielded up to 1300 kilograms per hectare, with a net profit of USD 126-637/ha. "Farmers in Pakistan already appreciate the value of mungbean," said **Warwick Easdown**, Regional Director for South Asia, "but these new cropping systems promoted by the Center are really expanding the options for the crop to improve farmer incomes." Farmers can now make up to USD 1428 per hectare when they grow the legume using improved management methods, including integrated pest management strategies, which have increased mungbean yield by 20%.

ROTATION WITH RICE IS NICE: Bacterial wilt, caused by the soil-borne pathogen *Ralstonia solanacearum*, damages solanaceous crops such as tomato and eggplant in both cool and warm conditions in AVRDC's host country, Taiwan, presenting a serious challenge for farmers. "Through previous trials in Yunlin County, where potatoes (also a solanaceous crop) are grown in rotation with rice, we learned that *R. solanacearum* phylotype IIB-1 does not survive well in flooded fields," said **Chih-Hung Lin**, Associate Specialist - Bacteriology. "We wanted to build on that knowledge and investigate phylotype IIB-1 survival rates in hot, wet lowland tropical conditions." In temperature trials (15, 25, and 35 °C), they learned that the pathogen's growth was curtailed at 35 °C; in pot trials simulating tomato planted in a rice rotation with flooded soil, the density of the pathogen was sufficiently reduced that 77 days after transplanting, no bacterial wilt was detected on the plants. The research will inform cultivation recommendations to help farmers deal with bacterial wilt.

PLANS TO THWART PESTS: "Integrated pest management strategies combine actions to intervene at different points during a pest's lifecycle," said Entomologist **Srinivasan Ramasamy**. "By using a package of methods, farmers have a better chance of controlling pest outbreaks." Srini's team, in collaboration with **Syed Nurul Alam** at the Bangladesh Agricultural Research Institute, has developed effective strategies to stymie some of the worst offenders in farmers' fields in Bangladesh. The eggplant fruit and shoot borer, for instance, can be kept at bay by removing dead or decayed plants from the field, installing pheromone traps, releasing natural enemies, and applying biopesticides. This combination of methods reduced shoot and fruit infestations by about two-thirds in winter and half in summer in Barisal, Patuakhali, and Jessore, resulting in yields about one-third higher than in non-IPM plots. Whitefly and fruit borer control measures in tomato in Barisal, Bangladesh (removing and destroying infested fruit, the use of biocontrol agents, pheromone traps, biopesticide sprays, and resistant varieties) nearly doubled the yield, from 19 to 36 tonnes per hectare. In Gazipur, the numbers of diamondback moth, a pest that causes great damage to cabbage crops, were significantly reduced from 63 larvae per head to a mere 3 to 9 per head by applications of three *Bacillus thuringiensis* biopesticides and a formulation of *Beauveria bassiana*. "For effective control, farmers can't rely on a single method," Srini said. "We're helping them mix it up."

WITH GREAT BENEFITS COMES GREATER RESPONSIBILITY: AVRDC has been promoting summer tomato production in southern Bangladesh through the USAID Horticulture project with the International Potato Center (CIP). Farmers that can produce a tomato crop during the hot, steamy monsoon season when supply is low and prices are high realize greater profits and can offer more choice to consumers. **Mohamed Mohiuddin Fakir** is one of the pioneers of summer tomato production from Ghoradoho village in Faridpur district. Tomato grows well during the country's mild dry winters, but it takes heat-tolerant varieties and a great deal of skill and care to produce the crop in summer. Mr. Fakir, a lead farmer, received two days of training on improved summer tomato production at the Bangladesh Agricultural Research Institute in Barisal. He then became a trainer for 40 other Faridpur farmers who were also keen to try summer tomato production using heat-tolerant varieties 'BARI Hybrid 4' from Lal Teer Seeds and 'Summer King' from ACI Seeds. He had to spend about USD 192 to establish his crop and he received USD 85 in support from the project for inputs such as seed, the polythene cover to protect the crop from rain, and tomatotone hormone. He harvested tomato throughout the monsoon season from September to mid-December, and he sold most of his produce in the local market for USD 0.57 – 1.15 per kg. With careful management he was able to obtain very high yields equivalent to 63 tonnes per hectare. His total income was USD 615 with a net return of USD 423 from his 80-square-meter land area. The other farmers he trained were equally successful. During summer, urban market demand for tomatoes is high. The project connected Mr. Fakir and his group with Dhaka supermarkets Agora, German Butcher and Levender, who were more than willing to buy the high

value produce. While these farmers have found success, off-season tomato production can be risky, as pest and disease pressure tends to be more intense, which prompts farmers to misuse pesticides to protect their valuable crop. In an evaluation of training on off-season tomato production offered to vegetable farmers in southwestern Bangladesh, AVRDC Socioeconomist **Pepijn Schreinemachers** found that while the training increased net household income in the off-season by 41%, the producers also increased their use of pesticides by about 50%. "It's important to emphasize safe and sustainable pest management methods when the Center introduces methods such as off-season production," said Pepijn. "We want the big improvements in income to not be overcome by health and environmental issues related to using more pesticides."



TINY AND TROUBLESOME: Meet the bruchid: barely bigger than the "B" in troublesome, this minute pest is a postharvest pain in mungbean (*Vigna radiata*). Bruchids (*Callosobruchus* spp.) breed rapidly in storage and often are not detected until seed has been stored for a while (e.g. for longer than three months). "By the time they are detected, the infested grain is usually unmarketable," said Legume Breeder **Ram Nair**. The best line of defense against the *Callosobruchus* crew: plant mungbean varieties bruchids don't like. A research team led by Ram confirmed bruchid resistance in two mungbean lines (VI001709

THE TRELLIS OF SUCCESS: Paddy rice is the main crop in West Singhbhum district, Jharkhand, the home of the tribal Ho community. Socially isolated, many of the Ho were unaware of the option of diversifying their crop production with vegetables. With support from the NGO Pradan, AVRDC is working in 72 villages in Jharkhand to promote new vegetable cropping options, safe vegetable production and home gardens under the project "Improving livelihoods with innovative cropping systems on the East India Plateau" funded by ACIAR. In 2013, **Jind Doraiburu**, a confident 32-year-old, was one of 25 women farmer-researchers selected from the villages adjoining Talaburu to conduct research trials as a part of the project. The AVRDC team introduced her to trellis cultivation of cucurbits during the rainy season. In the first year, she tried—and failed—to grow bottle gourd using this method. Flooding destroyed the crop on her small plot, but she realized the potential of the idea if the right field was used. Undaunted, in 2014 she started again, this time deciding to grow trellised cucumbers in a 180-square-meter field where she had grown maize the previous year. "I had a dual challenge with these research trials," she said. "One was proving that women can take a risk in trying new things in farming, and the second was to prove that the diversification of crops with cucumbers on a trellis will bring in more income." Her experiment worked: She was able to harvest about 365 kg of cucumbers for an average price of 20 rupees per kilogram. Her total income for the season was 7300 rupees, five times more than the investment of 1250 rupees and seven times more than what she usually gets by growing maize or rice in the same plot. The income also came in from August to October when there is normally no other money available. It helped her pay back the loan she got from her self-help group for medical treatment and the rest was invested in pesticides for tomato cultivation. Ms. Doraiburu, now widely known in the community for her promotion of trellis production methods, advises other women to give vegetable farming a try, and she is keen to continue her own crop experiments.

and VI001802) and in one black gram (*V. mungo*) line (VI001164). Resistance from VI001709 and VI001802 was crossed into the popular *V. radiata* line NM94, which has good agronomic qualities but is susceptible to bruchids. Progenies from crosses between VI001802 × NM94 (now in the seventh generation) and VI001709 BG × NM94 (fifth generation) show good resistance. A cross between black gram line VI001164 × NM94 is in the third generation. Populations of all these crosses continue to be repeatedly exposed to bruchids to identify lines with stable resistance. "The discovery of these bruchid-resistant lines means farmers will soon have better options to protect their mungbean harvests from damage," said **Mansab Ali**, Vegetable Program Leader for the USAID Pakistan Agricultural Innovation Project. "Posthavest losses from bruchids can be significant for this crop, but with resistant varieties farmers can reduce their storage losses, wait for better prices, and bring more mungbean to market."

IN FOCUS

GENDER

The discussions in the conversation on *Improving Future Horticulture as an Agent of Social Change* and *Women's Empowerment* during AVRDC's 40th Anniversary Colloquium "AVRDC @ 40: A Fresh Look Forward" provided new perspectives and a strategic direction for the Center to tackle the challenge of gender inequality, which often prevents agricultural development initiatives from achieving food and nutrition security for all.

The discussions sensitized the Center to the need for a common understanding of gender and prompted us to explore ways to integrate gender awareness into our development framework. As a follow-up, the Center developed and adopted a gender strategy with the following key elements:

i. a renewed commitment to mainstream gender into the Center's research and development activities

ii. foster a supportive organizational culture

iii. commit and develop resources

iv. build capacity in gender research and facilitation skills among staff and partners

With the enabling systems in place—strategy, greater emphasis and broadening of the gender agenda in the Center's planning process, explicit output targets for women and men in the Medium-Term Plans, staff capacity, etc.—the Center is now in the process of generating more gender outputs for analysis.

From the gender research point of view, the Center has generated a significant output from gender analysis work in rural Bangladesh. The relevant research paper, currently under internal review, explores how the training of women in home gardening and nutrition improved family incomes, social status, and personal empowerment, and contributed to gender equality.

From activities in the 2014-2016 Medium-Term Plan, the Center gathered sex-disaggregated data of beneficiaries for 14 outputs. The activities targeted vegetable producers (home and farm), supply chain and market players, and consumers. The activities focused on:

i. training in the conservation of germplasm and vegetable production, including integrated pest management (IPM) and input management, postharvest practices, food preparation and nutrition

ii. seeking feedback to understand the perception of farmers and consumers about plant pests and diseases, nutritional value, etc.

iii. surveys/situational analyses to understand farm level constraints and opportunities, evaluation of postharvest losses, and enlisting IPM, soil and water management practices

In total, 16,879 women were involved in these activities, accounting for 56% of all beneficiaries. Data from the outputs provide a basis for further analysis of the differences among women and men in access to resources. A follow-up action point to address the gender gap has been included in workplans for 2015.

Central Asia and the Caucasus

In 2014 major activities in the Regional Network for Vegetable Systems Research and Development (CACVEG) concentrated on collaborative research with partner institutes to disseminate new germplasm from the AVRDC genebank and breeding units; conduct regional varietal trials; study and develop new vegetable varieties; promote tomato grafting technology; collect baseline data on vegetables; and build capacity and awareness through workshops, training courses, and Farmers' Days.

Variety trials were conducted in different soil and climatic conditions in eight countries: Armenia (Research Center of Vegetable, Melon and Industrial Crops), Azerbaijan (Azerbaijan Research Institute of Vegetable Growing), Georgia (Research Institute of Crop Husbandry of Agrarian University), Kazakhstan (Kazakh Research Institute of Potato and Vegetable Growing), Kyrgyzstan (Research Institute of Crop Husbandry), Tajikistan (Research Institute of Horticulture and Vegetable Growing), Turkmenistan (Research Institute of Crop Husbandry) and Uzbekistan (Uzbek Research Institute of Vegetable, Melon Crops and Potato, and Uzbek Research Institute of Plant Industry). A total of 173 accessions (germplasm from AVRDC's genebank and improved germplasm from breeding units) of five species were evaluated. Seeds of promising lines (early maturing, higher yielding, resistant to diseases, good quality, etc.) were multiplied in 2014 to conduct competitive trials in 2015.

A total of 38 new varieties of 13 species were under State Variety Trials in the eight countries in 2014, including tomato (4), sweet pepper (7), hot pepper (8), eggplant (5), cucumber (1), marrow squash (2), custard squash (1), *Pisum* pea (1), basil (2), lettuce (1), celery (1), vegetable soybean (2) and mungbean (3).

From 2007 to 2014, a total of 42 new varieties of 8 vegetable crops including tomato (9), hot pepper (10), sweet pepper (8), eggplant, (1) vegetable soybean (6), mungbean (5), bean (2) and leafy cabbage (1) were registered in State Registries in Central Asia and the Caucasus countries. About one-third of the new varieties were developed from AVRDC genebank germplasm. Five new cultivars were released in 2014, including hot peppers 'Artsiv' (AVP802) and 'Loshtak' (AVPP0701) in Armenia, sweet pepper 'Shodlik' (0636-6056) in Uzbekistan, tomato 'Alsu' (CLN2425A) in Azerbaijan, and vegetable soybean 'Mravalmartsvala' (TOT5976) in Georgia. Seed multiplication of released varieties was conducted to provide farmers with sufficient seed.

Grafting to control Fusarium in tomato in an open field was conducted in Uzbekistan, and 60 tomato lines were evaluated as rootstocks for grafting of local varieties at the Uzbek Research Institute of Vegetable, Melon Crops and Potato. Tomato lines were evaluated and grafting technology was also applied at a farmer's farm in Armenia.

Trials of released mungbean cultivars 'Durdona,' 'Zilola,' 'Marjon' and 'Turon' were initiated in the Fergana Valley and Aral Sea Basin of Uzbekistan. Farmers are incorporating new mungbean varieties in wheat rotations. Seed of these four varieties (2150 kg), along with seed of vegetable soybean 'Sulton' (1000 kg) and yard-long bean 'Oltin soch' (10 kg) have been multiplied for distribution to farmers in 2015.

The regional office introduced 'Fayz baraka' and 'Mujiza'—two new cultivars of *Heliantus tuberosus* L. (girasol, topinambour) in Uzbekistan. The Ministry of Agriculture and Water Resources of Uzbekistan included both cultivars on a list of foods for a healthy diet, and in hospital meals for diabetics. New recipes were developed for the crop.

Two postdoc students continued research on AVRDC's vegetable soybean and hot pepper germplasm in Uzbekistan. One master's thesis on tomato was defended in Uzbekistan in 2014. Nine specialists from partner research institutes studied English in a course sponsored by the regional office.

Farmer field days were conducted across the region, attracting 472 participants, including 192 men and 280 women. Numerous training courses and workshops were held throughout the year to build capacity, strengthen skills and disseminate information.

WOMEN AND YOUTH GROWING STRONG IN CENTRAL ASIA: With AVRDC seed kits in hand, women and youth in the Bostanlyk district, Uzbekistan tilled small plots at home and around schools, made rows and furrows, sowed the seed, and watched seedlings develop into healthy fruiting plants. Now they are livening up their meals with flavorful, colorful, nutritious and, in some cases, new vegetables from their gardens. "We planted Chinese leafy cabbage, daikon, vegetable soybean and yard-long bean," said Ms. Karima Ziyaviddinova, a householder from Kibray. "Those were new ones for us! And we got some recipes to try them out. We like to can these crops for consumption during the long winters and early spring time." **Ravza Mavlyanova**, AVRDC coordinator for Central Asia and the Caucasus, prepared a cropping calendar for eight vegetable crops to guide the new growers, who later demonstrated their skill by producing 230 kg of seed of four new varieties for planting next season and to share with other gardeners.

Oceania

In 2014, activities in Oceania were coordinated from offices in the Solomon Islands (located in Honiara) and Fiji (located within the Ministry of Agriculture's Sigatoka Research Station). A newly recruited scientist is based in the Solomon Islands. Key partners in the Center's operations include the University of Queensland and University of Sunshine Coast in Australia, the Secretariat of Pacific Community (SPC), ministries of agriculture in Fiji, Samoa, Solomon Islands, and Tonga, and Taiwan Technical Missions in the Solomon Islands and Fiji. A new partnership was developed with Charles Darwin University and WorldFish to collaborate in Papua New Guinea and Solomon Islands, respectively.

Research and development activities focused on sustainable intensification of high-value vegetable crop production to improve the livelihoods of smallholders and their communities by increasing income through vegetable production.

Oceania has been neglected by the international seed industry due to its small market. The national systems lack the capacity to implement a stronger vegetable seed-related research and extension program. A sustainable supply of quality seed is one of the major vegetable production constraints. AVRDC facilitates the development of the seed sector in the region. For the past six years, AVRDC has regularly evaluated improved vegetable lines or cultivars in the Solomon Islands in collaboration with the Ministry of Agriculture and Livestock (MAL) and with the support of the Australian Centre for International Agricultural Research (ACIAR). In February 2014, AVRDC tomato line CLN2585D was officially recommended by MAL. Elite open pollinated vegetable lines have been introduced and evaluated by AVRDC in collaboration with Fiji's Ministry of Agriculture; an AVRDC tomato line, CLN3150A-5, has been selected for official release in 2015.

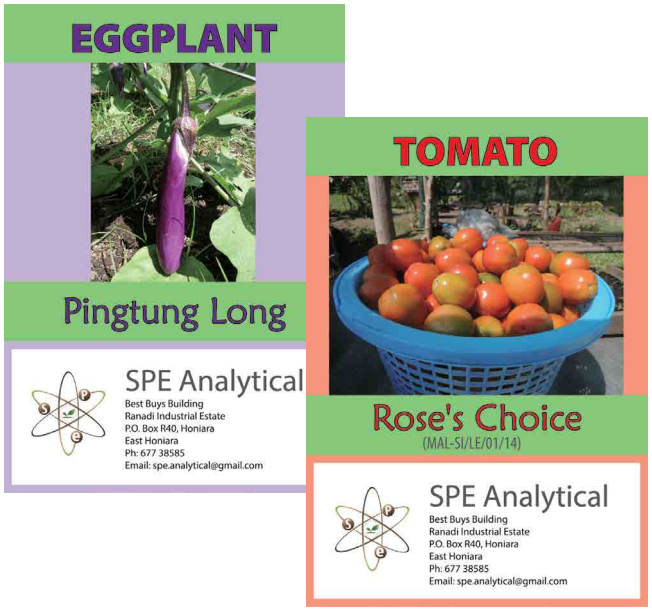
Tomato is an important cash crop for smallholders in the South Pacific. However, growing tomato during the rainy season (November to April) is difficult due to the crop's lack of flood tolerance. Grafting tomato onto flood-tolerant eggplant rootstocks can provide the solution. Selected eggplant rootstock varieties from AVRDC were evaluated in the Solomon Islands in December 2013 and February 2014 in collaboration with the Taiwan Technical Mission and MAL. Non-grafted tomato plants rotted due to the high rainfall, while grafted plants with eggplant rootstocks (EG190, EG195, or EG203) produced 2.1 to 3.7 kg of marketable fruit per plant.

The Participatory Guarantee System (PGS) in vegetable production and marketing adopted by three farmer groups (Qereqere, Nawamangi, and Narata) in the Sigatoka Valley of Fiji is beginning to have an impact after nearly three years of training and mentoring. An umbrella company, "Sigatoka Valley PGS Farmer Company Ltd." was formed in October 2014 to represent the groups in price and quantity negotiations, and an agreement between the company and two resorts (Shangri-La Fijian Resort and Intercontinental Resort) was signed later in the month. The agreed price (US$4 per kilogram) is about four times higher than prices in the local market. However, heavy rain from January to March constrained production, making it difficult for farmers to meet their obligations. Techniques for producing tomato during the rainy season should be evaluated.

In collaboration with SPC and Ministry of Agriculture, AVRDC facilitated a Training of Trainers workshop on good agricultural practices and seed production at Fiji's Sigatoka Research Station from 10-14 March 2014 to provide the 34 participants (3 women, 31 men) with background information, knowledge, skills and practical experience. The trainers learned to save their own seeds, produce healthy seedlings, identify and protect natural enemies, how to safely use pesticides, how to improve and maintain soil health and fertility, and other integrated crop management practices.

A GUARANTEE OF GOOD QUALITY: Groups of farmers from the East and West Bank of Fiji's Sigatoka Valley in the Solomon Islands joined the Participatory Guarantee System for high value vegetable crops in 2014. The system is a market access program where producers are directly linked to guaranteed, high-value markets—mostly institutional consumers such as hotels, restaurants, hospitals, etc. The producers would otherwise have difficulty selling their produce, or at best struggle to sell in spot markets.

Ellen Iramu, project coordinator, said that by honing their vegetable production and business skills, the farmer groups were able to establish profitable contracts to supply resorts and other companies with high quality tomatoes, peppers and other vegetables.



SEED SECTOR SAVVY: Good quality seed available at the right time for planting is the essential element for successful farming. To develop a robust seed system in the Solomon Islands, AVRDC regularly evaluates improved vegetable lines or cultivars in collaboration with the Ministry of Agriculture and Livestock (MAL). In February 2014, AVRDC tomato line CLN2585D was officially recommended by MAL as 'Rose's Choice'—named after local farmer Mrs. Rose Sese, who allowed AVRDC to trial the tomato at her farm in Areatakiki, Central Guadalcanal. 'Rose's Choice' joins 'Pingtung Long', an AVRDC eggplant line distributed in the Solomons for the past five years. The two open-pollinated varieties have increased farmers' choices for quality vegetable seed. SPE Analytical, a soil testing laboratory in the Solomons, has contracted with a local farmer to produce seed of the two varieties, and is currently selling the seed.

IN FOCUS

IMPACT EVALUATION

In April 2014, AVRDC created a Monitoring and Evaluation group and appointed a Lead Specialist – Monitoring & Evaluation, based at headquarters. The group reports to the Deputy Director General - Research. In November 2014 it was proposed that the group should be renamed 'Impact Evaluation' as this more accurately captures its task to assess the longer-term impact of activities beyond the lifetime of individual projects. The impact evaluation team currently has two internationally recruited staff (of which one is based at AVRDC East and Southeast Asia, Bangkok, Thailand), one short-term consultant, and one vacancy for a Taiwan nationally recruited staff member to be filled in early 2015. Three agricultural economists based in Africa also contribute to impact evaluation. The activities of the impact evaluation group are both project-based and Center-wide; the impact evaluation group thus receives funding from projects but also has a core-funded operational budget.

In terms of project-based evaluations, the group successfully completed an impact evaluation of farmers' training in off-season tomato production in Bangladesh and an impact evaluation of women's training in home vegetable gardening on gender equality and women empowerment, also in Bangladesh. The evaluation of home gardens used a mixed-methods approach that combined quantitative and qualitative data. A quantitative post-intervention survey among women home gardeners in Bangladesh was also conducted, which makes it possible to quantify impact using a double difference method. Baseline data were also collected for impact evaluations of school vegetable gardens in Bhutan, Burkina Faso, Nepal, and Indonesia. These studies used a randomized controlled trial design. Finally, baseline data were collected for an impact evaluation of a vegetable production training program targeting rural youths in Ethiopia, Mozambique, Malawi, and Tanzania.

In term of Center-wide studies, impact evaluations were initiated on AVRDC improved planting material and genebank accessions in Eastern and Southern Africa (tomato and African eggplant) and South Asia (tomato and sweet/chili pepper). The objectives of these studies are:

- to articulate the process of how AVRDC germplasm has made an impact on the development of the vegetable sector, and the seed sector in particular;
- to quantify the number of released cultivars that have AVRDC-developed germplasm in their pedigrees, and to what degree, and to estimate their adoption rate (planted area and number of farmers); and
- to quantify the economic surplus generated by the adoption of the most prominent cultivars containing AVRDC germplasm.

Internal institutional mechanisms to conduct robust impact evaluation were strengthened by standardizing study protocols for impact studies and initiating a system of internal, and where appropriate, external review of protocols. The internal capacity of AVRDC staff in impact evaluation was strengthened through various seminars and the setup of an online discussion platform using Google Groups. Linkages with outside communities of practice was expanded to include the Association of International Research and Development Centers for Agriculture (AIRCA) and the International Initiative for Impact Evaluation (3ie).

Some of the data collection efforts (e.g. school vegetable gardens) need several years to complete, while others (e.g. home gardens, germplasm impact) will give results in the next few years. The achievements in 2014 has established an important foundation for more robust impact evaluation and evidence-based decision-making at AVRDC.

Projects in 2014

Project Title	Donor Name	Duration	Project budget (US$)
Development of a Vegetable Strategy for AGRA	Alliance for a Green Revolution in Africa	2014-2016	180,000
Multi-location evaluation of tomato lines carrying different combinations of *Ty* genes for resistance against begomovirus infection	Asia and Pacific Seed Association	2014-2016	278,263
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	2011-2016	906,484
Improving livelihoods with innovative cropping systems on the East India plateau	Australian Centre for International Agricultural Research	2012-2015	97,577
Developing an integrated participatory guarantee system in the Pacific Islands in support of sustainable production of high-value vegetable crops	Australian Centre for International Agricultural Research	2012-2014	324,653
Increasing productivity of allium and solanaceous vegetable crops in Indonesia and sub-tropical Australia	Australian Centre for International Agricultural Research	2013-2015	53,133
Improving income and nutrition in Eastern and Southern Africa by enhancing vegetable-based farming and food systems in peri-urban corridors	Australian Centre for International Agricultural Research	2013-2016	2,147,145
Promoting traditional vegetable production and consumption for improved livelihoods in Papua New Guinea and Northern Australia	Australian Centre for International Agricultural Research	2014-2018	137,475
Improving Mungbean Breeding and Production	Australian Centre for International Agricultural Research	2014-2014	77,869
Integrated Systems for the Humidtropics	CGIAR	2012-2014	1,797,601
Case Study on enhanced nutritional outcomes of populations through nutrition-sensitive agricultural promotion by a vegetable seed company in Bangladesh	CGIAR	2013-2015	100,000
Research Program for Aquatic Agricultural Systems	CGIAR	2014-2015	30,000
Strengthening the Capacity of Vulnerable Communities to Prepare for the Recovery from Floods in India	COFRA Foundation, India	2013-2015	108,634
Strengthening the cooperation between AVRDC - The World Vegetable Center and Taiwan research institutes on vegetable research and development	Council of Agriculture, Taiwan	2014-2014	378,549
Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia	European Commission	2012-2015	388,991
Enhancing horticultural productivity, incomes and livelihoods through integrated management of aphid pests on vegetables in sub-Saharan Africa	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2011-2014	94,646
Local Focus: safe and effective pest and crop management strategies to strengthen the vegetable value chain in the humid tropics	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2012-2015	132,927
Beating Begomoviruses: Better livelihoods for farmers in tropical Asia with begomovirus resistant tomato, hot pepper and mungbean and integrated disease management	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2012-2015	1,463,415

Project Title	Donor Name	Duration	Project budget (US$)
Implementation of integrated thrips and tospovirus management strategies in smallholder vegetable cropping systems of eastern Africa	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2013-2014	92,804
Overcoming conservation and germination problems of selected indigenous vegetables	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2013-2016	73,171
GlobE UrbanFoodPlus; Controlled central factorial experiments for participatory development, evaluation and demonstration of improved nutrient and water management strategies	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2013-2016	136,463
Horticultural Innovations and Learning for Improved Nutrition and Livelihoods in East Africa	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2013-2016	243,902
Vegetable cucurbits for nutrition-sensitive home and school gardens in Southeast Asia	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2014-2015	73,171
Attraction in Action: Using pheromones and other safe and sustainable management strategies to reduce losses from insect pests and plant diseases on vegetable legumes and leafy brassicas in Southeast Asia	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2014-2017	1,463,415
Enhancing the Livelihood Opportunities of Smallholder African Indigenous Vegetable Producers through the Development and Implementation of IPM Measures for Arthropod and Nematode Pests	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2014-2016	203,946
A better bitter gourd: Exploiting bitter gourd (*Momordica charantia* L.) to increase incomes, manage type 2 diabetes, and promote health in developing countries	Federal Ministry for Economic Cooperation and Development-Gesellschaft für Internationale Zusammenarbeit, Germany	2011-2014	1,463,415
RegenIntro: Introduction of accessions from the regeneration initiative into the international collections held by AVRDC	Global Crop Diversity Trust	2013-2015	59,451
Vegetable seed kits for flood-affected households in Fiji	Government of Fiji	2012-2014	15,200
Improving Rural Livelihoods through Innovative Scaling-up of Science-led Participatory Research for Development in Karnataka	Government of Karnataka, India	2013-2017	70,000
Seed Certification Training for HKI's Enhanced Homestead Food Production Project in Sengerema and Ukerewe, Tanzania.	Helen Keller International	2014-2014	12,100
Sustainable African Indigenous Vegetable Production and Market-Chain Development for Improved Health and Nutrition and Income Generation by Smallholder Farmers in Kenya, Tanzania and Zambia	Horticulture Collaborative Research Support Program, USA	2011-2014	47,400
Extension of Appropriate Postharvest Technology in sub-Saharan Africa: A Postharvest Training and Services Center	Horticulture Collaborative Research Support Program, USA	2012-2014	260,334
Good Seed Initiative	Irish Aid, Ireland	2013-2014	80,722
Screening for development of begomovirus-resistant processing tomato hybrid	Kagome Co. Ltd., Taiwan	2010-2015	88,328
Developing marker-assisted selection tools for Lal Teer's breeding program	Lal Teer Seed Ltd. Bangladesh	2013-2014	25,000
Sustainable Actions for Edible Gardens	Milan Municipality, Italy	2014-2015	12,195
Networking to Enhance International Cooperation in Vegetable Research and Development	Ministry of Foreign Affairs, Taiwan	2014-2014	767,800

Project Title	Donor Name	Duration	Project budget (US$)
Mobilize resistance genes from wild tomato for breeding salt tolerant tomato cultivars	Ministry of Science and Technology, Taiwan	2014-2016	79,401
Biotechnology-Assisted Development of Virus-Resistant Varieties and Populations of Squash for Climate Change Adaptation	National Science Council, Taiwan	2011-2014	56,782
Targeting Induced Local Lesions IN Genome (TILLING) of tomato for multiple virus resistance	National Science Council, Taiwan	2011-2014	56,782
Identification of virus resistance genes in pumpkin and development of associated marker-assisted selection tools	National Science Council, Taiwan	2013-2014	28,391
Local adaptation of *Ralstonia solanacearum* phylotype IIB sequevar 1 strains in Taiwan and identification of their resistance sources in tomato	National Science Council, Taiwan	2013-2015	59,905
Support for the implementation of PADFA's onion seed programme	PADFA (Commodity Value-Chain Development Support Project, Cameroon)	2012-2015	194,845
Development of Breeding Techniques and Selection of Virus Resistant Germplasm in Pepper and Tomato	Rural Development Administration, Korea	2013-2015	120,000
Development of Breeding Techniques and Selection of Disease Resistant Germplasm in Cucurbits	Rural Development Administration, Korea	2014-2016	120,000
Postharvest program for RDA seconded scientist	Rural Development Administration, Korea	2014-2015	120,000
Improving vegetable production and consumption for sustainable rural livelihoods in Jharkhand and Punjab, India	Sir Ratan Tata Trust, India	2008-2014	735,783
Vegetables Go to School: Improving Nutrition through Agricultural Diversification	Swiss Agency for Development and Cooperation	2013-2015	3,530,303
Evaluation and Screening of Syngenta Maize and Vegetable Hybrids for Adaptation in Nigeria And Skills Development Program for Syngenta Staff	Syngenta Crop Protection AG	2014-2017	42,000
Tomato heat tolerance	Takii & Co. Ltd., Japan	2013-2014	18,000
Mobilizing vegetable genetic resources and technologies to enhance household nutrition, income and livelihoods in Indonesia	United States Agency for International Development	2010-2015	1,439,784
Improving incomes, nutrition and health in Bangladesh through potato, sweet potato and vegetables	United States Agency for International Development	2011-2014	2,183,241
Postharvest Program	United States Agency for International Development	2012-2017	5,000,000
Improving vegetable production and consumption in Mali	United States Agency for International Development	2013-2014	800,000
Improving nutrient supplies and diet diversity with vegetables in Mali	United States Agency for International Development	2013-2014	500,000
Agricultural Innovation Program: Promoting Science and Innovation in Agriculture in Pakistan	United States Agency for International Development	2013-2014	1,096,706
Deploying Improved Vegetable Technologies to Overcome Malnutrition and Poverty in Mali	United States Agency for International Development	2014-2017	3,200,000
Nutrition Sensitive Vegetable Technologies in Tajikistan	United States Agency for International Development	2014-2016	591,147
Deploying Vegetable Seed Kits to Tackle Malnutrition in Cambodia, Kenya, Liberia, Tanzania and Uganda	United States Agency for International Development	2014-2017	6,000,421
Enhancing partnership among Africa RISING, NAFAKA and TUBORESHE CHAKULA Programs for fast-tracking delivery and scaling of agricultural technologies in Tanzania	United States Agency for International Development	2014-2015	199,018
Africa RISING: Enhancing vegetable value chains in rice-based and sole crop production systems to improve farm household income and consumer access to safer vegetables in Morogoro, Tanzania	United States Agency for International Development	2012-2015	344,700

Project Title	Donor Name	Duration	Project budget (US$)
Cereal-based Systems of West Africa: Vegetables and associated best management practices in cereal-based crop production systems to improve income and diets of rural and urban households in Northern Ghana and Southern Mali	United States Agency for International Development	2012-2015	618,600
Urbanisation and its Impacts on the Use of Natural Resources in Africa	Volkswagen Stiftung, Germany	2014-2015	69,024
Enhancing Productivity, Competitiveness and Marketing of Traditional African (Leafy) Vegetables for Improved Income and Nutrition in West and Central Africa	West and Central African Council for Agricultural Research and Development	2013-2016	433,608

Management

Management at AVRDC – The World Vegetable Center comprises the Director General, the Deputy Director General for Research, the Deputy Director General for Administration and Services, the Director of Human Resources, and the Director of Finance. Working together as a team, the Management leads the Center toward achieving its goal of alleviating poverty and malnutrition in the developing world through the production and consumption of health-promoting vegetables. Through 2014, the Management set the strategic direction, guided progress, mentored staff, took appropriate action as needed and ensured accountability. Many management-related issues were discussed and resolved by the Center's Institutional Management Committee, chaired by the Director General, which consists of the Management team with the Center's Regional Directors. This committee manages the Center's activities in line with the strategies, policies, and plans set by the Board of Directors.

At the global policy level, AVRDC (represented by the Deputy Director General for Research) was invited to be actively involved in the Sustainable Development Solutions Network, a global initiative of the United Nations to frame the new Sustainable Development Goals, a proposed set of targets for international development to replace the Millennium Development Goals. This involved formulating researchable questions to frame goals, targets and indicators for global performance in sustainable agriculture and food systems. It provided an opportunity to ensure that nutrition and dietary diversity are visible at a global level, and also enabled the Center to develop a more informed strategy for the future aligned with the Sustainable Development Goals.

Within a more specific global niche, AVRDC's Director General guided the development of the initial collective-work pathway for the Association of International Research and Development Centers for Agriculture (AIRCA), a newly formed consortium of centers of which AVRDC's Director General is now the chair. The Director General also serves as Chair of the Board of the Global Horticulture Initiative and as a member of the International Advisory Board of the USAID Horticulture Innovation Lab, thus bringing AVRDC's global experience along the vegetable value chain to the forefront of world horticultural research and development, as well as helping to guide these various initiatives and contribute to international policy through their strategies.

An External Program and Management Review (EPMR) was conducted to assess the Center's performance for the period from 2008 to 2014. The Management successfully facilitated the EPMR Panel's requirements to interview staff members, the donor community, public and private national and international partners, and to assess the Center's work at headquarters and in the regions (East and Southeast Asia, South Asia, Central Asia and the Caucasus, West and Central Africa, Eastern and Southern Africa, and Oceania). Overall, the EPMR Panel commended the Center's significant roles and achievements in undertaking its important mission. No major concerns were raised, but some recommendations and suggestions were formulated to improve the Center's performance in delivering its research and development outputs to create better future outcomes and impact.

Research for development

The Center's research and development portfolio is led by the Deputy Director General for Research (DDG-R) with the support of the Institutional Research and Development Committee. This committee reviewed and monitored the research and development agenda consistent with the Center's 15-year Strategic Plan and its Medium-Term Plan. The Center's strategic research and development vision was also developed to attract funding in coordination with the Center's resource mobilization efforts. In an effort to balance the Center's research and development activities and to create an innovative environment, the Management took the approach of stimulating research initiatives among staff members by providing support from an Innovations Fund to implement short-term research activities that would otherwise not be supported by external funding. The research supported by the Innovations Fund is intended to test new ideas, assess novel approaches, and create new opportunities for which external project funding might then be a possibility. Seven research proposals were approved in 2014 with wide-ranging topics such as bioinformatics pipelines for optimizing genotyping, restorer cytoplasm for cytoplasmic male sterility in pepper, quarantinable pathogens, trichome types associated with resistance in tomato to whiteflies, pepper-*Colletotrichum* interactions, use of starter solutions, and creation of a centralized database for seed ordering and distribution in Tanzania.

The Center very much appreciates the strong support from its many donors in 2014, especially the core funding from Taiwan's Ministry of Foreign Affairs (MOFA) and Council of Agriculture (COA), the United States Agency for International Development (USAID), the UK's Department for International Development (DFID), Korea, the Royal Government of Thailand, the Philippines, the Federal Republic of Germany, and Japan. In 2014, Taiwan remained one of the Center's major donors, with a significant core contribution that helped to sustain the Center's basic activities. A special project funded by MOFA supported global activities spanning several regions, including South Asia, Southeast Asia, Oceania, and Central America, and a Center-wide research project funded by COA complemented the Center's research portfolio. The Center made a concerted effort to merit the host country's generous core contribution support with outstanding reporting to the Council of Agriculture on the Center's achievements and annual work plans.

Many donors fund specific projects, and in 2014, AVRDC's project (restricted) funding was received, among others, from the Swiss Agency for Development and Cooperation (SDC), USAID, the Australian Centre for International Research in Agriculture (ACIAR), CGIAR, and the Federal Republic of Germany through *Gesselschaft für Internationale Zusammenarbeit* (GIZ). The Management ensured linkages with the donor community were sustained and strengthened. In 2014, this resulted in higher public awareness of the Center's work in many countries, a substantially higher financial commitment from USAID, and closer collaboration with the Federal Republic of Germany through GIZ and the Advisory Service on Agricultural Research for Development (BEAF) for human resources capacity building through the Centre for International Migration and Development (CIM) of agricultural experts and its master's degree student internship program.

Services

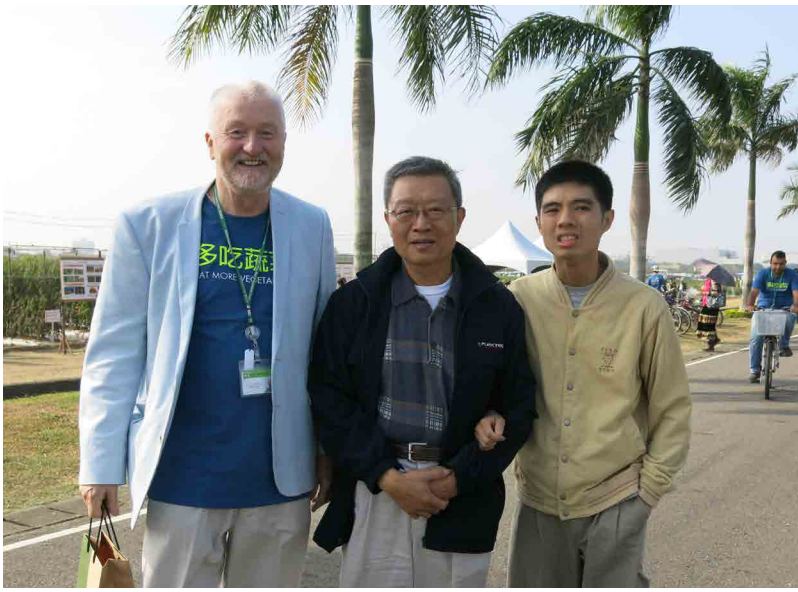
The Human Resources function of the Center continued to give emphasis to improving the organizational design, strengthening the policy framework, acquiring and developing talent, and enhancing the engagement of staff in the Center's mission. Staff policies for headquarters and for AVRDC East and Southeast Asia were reviewed and modified. Compensation practices were also reviewed at the institutional and individual levels and adjustments, where necessary, were made for equity. The competency requirements to meet strategic and project needs were the basis for the recruitment of positions, and 15 international staff and several national staff were successfully recruited in 2014 to strengthen competencies in agronomy, breeding, grafting, nutrition, postharvest, project development, socioeconomics, training and other disciplines.

As part of staff capacity building, two intensive training workshops were conducted at AVRDC South Asia in Hyderabad, India and AVRDC Eastern and Southern Africa in Arusha, Tanzania to improve skills in writing proposals, reports, and publications. Several staff members were nominated for training in professional institutions to develop their capacity and skills in leadership, communication, and project management. The computerized performance management system is now well institutionalized and links directly to the performance reward and contract renewal process; it covers all international staff and senior national research and support staff.

The Center's Financial Services continues to support AVRDC in improving its financial health and long-term stability by ensuring that financial management processes, including financial planning, resource allocation, and monitoring and reporting are properly executed. A significant and increasing portion of the Center's revenue comes from (restricted) project financing. It is therefore important that the Center includes in all project proposals the full cost of the proposed actions to guarantee long term financial sustainability. The Center continues to build its financial reserves as part of its risk management strategy. The reorientation of responsibilities within the finance group, which began in 2013 to provide a wider range of responsibilities to the finance officers and avoid overspecialization, is showing impact. The internal finance network with a shared repository, which was set up to complement Maconomy, the Center's enterprise resourcet planning system, has meant the Center is more resilient and has increased its capacity to cope with staff turnover and changing (donor) demands for financial information. Maconomy offers a range of options for budget monitoring. A start has been made to streamline the use of these options to cope with the growing number of projects while continuing to meet the reporting requirements of donors and the Board of Directors.

The Deputy Director General for Administration and Services supported the Director General as the Center's chief contact with the governmental authorities of the Center's host country, the Republic of China (Taiwan), providing insight and guidance on matters of security, diplomatic, environmental and biosafety concerns related to Taiwan. With this capacity, the Center ensured that operations complied with Taiwan's laws and regulations, gave focused and targeted responses to the respective authorities on institutional issues, took actions to address the host country's concerns, interests or expectations, and ensured that fundraising efforts with various host country agencies were coordinated.

For the first time in the Center's history, the general public was invited to visit the headquarters campus during Open Day on 13 December 2014. This event to promote the Center's visibility in Taiwan, increase public awareness of the Center's activities and achievements, and highlight the production and consumption of vegetables attracted more than 6,000 visitors of all ages. Highlights of Open Day included scientific displays of research activities, field displays of more than 300 improved vegetable cultivars, an exhibition of the diversity of pepper and eggplant germplasm in the Genebank, demonstration of more than 100 global crops in the Demonstration Garden, educational activities such as self-DNA extraction and tomato grafting, and a Farmers' Market joined by many local partners including farmers' associations, cooperatives, individual farmers, and local food/drink vendors.



The Office of Deputy Director General for Administration and Services led several administration and support groups to ensure efficient and harmonious service for the research and development programs. Purchasing, Travel, General Affairs, Food and Dormitory Services, and Technical Services provide substantial support to the Center's research and development activities. These groups ensure up-to-date standard operating procedures, building essential infrastructure for safety and efficiency, providing high quality services to institutional functions, purchasing and importing research materials and supplies, coordinating staff members' and visitors' international travel, and obtaining entry visas to Taiwan and other countries.

In 2014, the Center's support on legal and intellectual property (IP) included the preparation of institutional template agreements for hosting partners on AVRDC premises, the development of Memoranda of Understanding and Memoranda of Agreement to set joint research priorities for future research collaborations, and the development of tools to facilitate dissemination of foundation seeds, both with partners and national agricultural research systems. Several partner agreements were reviewed from the IP perspective to ensure that the outputs of joint research are managed as public goods while respecting the IP policies of partners. The DDG-R's office also attended to various queries concerning germplasm transfer and management, and specifically in Africa, has successfully obtained the consent of African partners to deposit their vegetable germplasm collection into the AVRDC genebank to be distributed in accordance with AVRDC policy. AVRDC's legal status in India was also considered closely in light of queries from the Sir Ratan Tata Trust.

Internal Audit helped the Center maintain good governance to safeguard donors' interests and reinforce compliance with the Center's national and international regulations. In 2014, Internal Audit audited inventory management and purchasing at headquarters, routine operations at AVRDC South Asia and West and Central Africa, as well as the Center's enterprise resources planning system (Maconomy). At headquarters, a recommendation was made to streamline Maconomy's internal access to completed procurement transactions for analytical evaluation of vendors. Likewise, Internal Audit assisted regional offices on property management assignments to ensure compliance to the Center's requirements, giving due consideration to the limited manpower resources.

Collective action

Institutional committees worked to address and streamline particular aspects of research and development activities. The Global Risk Management Committee formulated and recommended strategies to manage risks, from regular checks of potential hazards at the workplace and deployment of fire-fighting equipment and first aid kits to responding to public health issues (e.g. the Ebola outbreak in West Africa), close monitoring of risk and safety, and contingency plans for staff evacuation in regions experiencing social strife and insurgency.

The Agricultural Chemicals Control, Campus Environment, and Health and Safety Committee ensured all custodians of toxic chemicals were informed about the Environmental Protection Administration (EPA)'s new regulations for managing laboratory waste. At headquarters, the Center joined a prevention organization consisting of 42 local institutions that are manufacturing, using, storing or transporting toxic chemical substances and has taken appropriate action with respect to protective equipment for the safe handling and disposal of toxic chemicals. The Institutional Biosafety and Ethics Committee focused on ensuring that AVRDC's research and development activities comply with biosafety regulations, requirements and restrictions at headquarters in Taiwan, and in other countries where AVRDC has activities that may be affected by biosafety compliance requirements. The committee is the only conduit for obtaining approval for AVRDC activities covered by biosafety regulations and for those employing animals in experiments.

The Green@AVRDC Committee reviewed and assessed the Center's methods and approaches in its use of utilities and other activities that have an impact on the environment. The committee recommended improvements and developed procedures to raise resource use efficiency and reduce the Center's carbon footprint. Linking with the headquarters-based Laboratory and Greenhouse Space Allocation Committee, an evolving plan was established for more productive and cost-effective use of infrastructure, fields, and facilities. The Assets Committee ensured equitable allocation of resources for the Center's global capital requirements and asset reallocation and replacement for higher efficiency and uninterrupted operations.

(*left*) The Center's newest board member, Dr. Jen-Pin Chen (*center*), with his son and Director General Dyno Keatinge during Open Day 2014.

Biometrics

Biometrics enables researchers to look at large sets of data and condense them into meaningful and valid information. This role of Biometrics ensures the high quality research output of AVRDC. Through the efficient use of biometrical services, scientists avoid problems in experimental trials and data analysis, and incorrect conclusions.

Sound biometrical methods and access to statistical information and techniques used in research are important in achieving scientifically reliable and high quality research output. AVRDC's biometrics resource covers all biometrics-related aspects of experimentation from experimental design, field plot techniques, plot sampling techniques, remedial measures for problem data, and statistical analysis of data, to presentation and interpretation of results. The quality of all scientific manuscripts is ensured through comprehensive statistical review of reports to ensure and maintain AVRDC credibility among donors, clients, and the entire scientific community.

The Biometrics office provides the following consulting services to research scientists and staff at headquarters and in the regions: 1) statistical review of reports, proposals, abstracts, scientific papers, and posters for publication; 2) evaluation of experimental/sampling plans; 3) statistical analysis of data; 4) capacity building through training programs on experimental design, data management and analysis, and interpretation/presentation of results to improve and enhance the skills of staff and national agricultural research system collaborators in conducting research; and 5) advice on how to use statistical software available at AVRDC.

Generally, the outputs of the Biometrics office are: 1) advisory support – provide consulting services or general help in designing experiments, dealing with data, or other statistical issues; 2) training – in-country and in-house, aimed at improving the skills and understanding of researchers, national collaborators, and scientists who may be infrequent users of statistics, 3) assurance of high quality data – a measure put in place to assure quality of research outputs right from the start at the planning stage through detailed evaluation of experimental plans, which also assures proper recording and archiving of procedures used in each experiment; and 4) statistically reviewed reports, proposals, and scientific manuscripts submitted for publications in international peer-reviewed journals.

Communications and Information

Creating media strategies and promotions to influence public perceptions of the Center engages the eight members of the Communications and Information group (secretary, graphic designer/photographer, visitor services coordinator, assistant, three librarians, and a group head/editor).

To foster public awareness, the group contacts local and international media, handles press queries, and develops success stories for donors. Communications and Information published 12 issues of *Fresh*, the AVRDC newsletter, distributed to 3922 subscribers (a 25% increase over 2013); prepared promotional and scientific brochures and posters, videos, and PowerPoint presentations; and produced extension publications on various aspects of vegetable production. International press coverage about the Center in 2014 included television programs aired on stations in Burkina Faso, Taiwan, Tanzania, and Thailand; reports on global aggregator websites Food Tank, Fresh Fruit Portal, and Huffington Post; articles published in the Guardian, Christian Science Monitor, International Innovation, Appropriate Technology, The Hindu, Taiwan Review, and Asian Seed magazines; and broadcasts on Radio New Zealand, ABC Australia, and National Public Radio (USA).

The Center's website (avrdc.org) receives approximately 13,000 unique visitors each month, a 35% increase over 2013. The site offers news, publications, video access, online ordering for seed, and other services. Communications coordinates social media outreach through Facebook pages in English and Chinese (www.facebook.com/WorldVegetableCenter), Twitter (@go_vegetables), and a YouTube channel (www.youtube.com/WorldVegetableCenter), and also maintains the Greenhouse, the Center's intranet.

The Center's editor reviewed more than 200 articles, abstracts, books, proposals, newsletters and other documents in 2014 for grammar, style and coherence. Major publications produced during the year included the *Annual Report 2013, Year in Review 2013, Medium-term Plan 2014-2016*, and the *8th EPMR Report*. The Communications Head led two week-long writing workshops for regional staff in Africa and India; a success story writeshop for staff in Thailand; and a day-long development communications session for the 33rd International Vegetable Training Course.

Open Day 2014, held on December 13, drew more than 6,000 visitors to headquarters to view vegetable crops in the field, visit booths showcasing different aspects of the Center's local and global research and development work, and engage in educational games and activities. Reporters from 11 local and national media covered Open Day, the largest public event in the Center's history. The Communications team handled overall coordination for Open Day, and also designed a special logo, prepared banners, posters, signs, displays, maps and a guide booklet, and directed media outreach.

Center headquarters welcomed 1028 visitors in 2014 from 60 countries; all visitors received briefings and tours tailored to their specific interests. Communications designed the Center's booth for the 2014 International Horticultural Congress, and prepared designs for the AVRDC Organic Farm training center to create an informative and attractive experience for trainees. The AVRDC Library's *Library News*, a regular e-newsletter, keeps staff up-to-date on recent acquisitions and the latest articles published by colleagues. Open Day 2014 t-shirts and vegetable Post-it notes were added to the Center's corporate gifts.

Global Technology Dissemination

The Global Technology Dissemination (GTD) group conducted a wide range of activities in 2014 in the areas of capacity building, technology dissemination and agricultural development innovation.

The group led or supported many activities in AVRDC projects in Asia, Africa and the Pacific. GTD led a research and development project in Indonesia, which included Farmer Field Schools with 721 women and 1443 men participants, school gardens, and farmer-managed variety trials of AVRDC and other vegetable lines; farmers and nursery operators are adopting tomato grafting under this project. In addition, 30 off-season tomato farmers in Bangladesh were trained on healthy seedling preparation (grafted and non-grafted) and related field management. GTD initiated a gender research and development project in Bangladesh in 2014. Three women and 31 men in Fiji were trained in integrated crop management. In addition, seeds of two accessions of recommended AVRDC eggplant and chili pepper rootstocks for grafting were multiplied and processed; in total 1.08 kilograms of quality seed was produced for distribution.

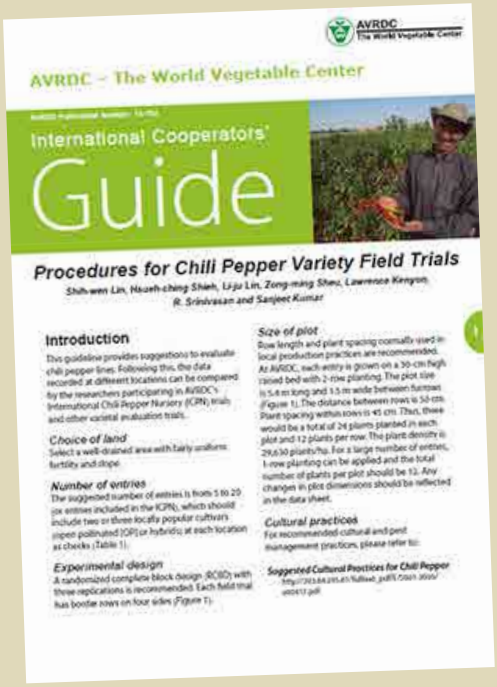
GTD established a Google Group called "INNOVEG" to network AVRDC scientists working on knowledge-sharing, technology innovation, and scaling up/out; 43 AVRDC scientists in Africa, Asia and the Pacific are presently members.

GTD managed the headquarters Demonstration Garden, which showcases the Center's technologies to visitors and trainees, including 199 accessions representing 137 vegetable species. Nutritional and other information about each crop can be found on signs that are constantly updated. Tours of the Demonstration Garden were given to 936 visitors from 68 countries in 2014. The Center's achievements were promoted at Taiwan's annual "Seed and Seedling Festival and Exhibition of Agricultural Achievements" and the group strongly supported Open Day.

The group published *Feedback from the Field*, a quarterly bulletin that communicates technology applications and urgent issues from the field to its readers. This publication is disseminated via the AVRDC website, email and Facebook. Other publications on procedures for chili pepper field evaluation trials, phosphorous acid, and starter solution were also produced. The group also coordinated the Center's Disaster Response Program, which features seed distribution of hardy, fast-growing and nutritious vegetable crops to disaster survivors. Approximately 850 kilograms of seeds were multiplied to replenish stocks. In collaboration with the breeding groups, a web-based seed catalog that greatly facilitates germplasm transfer was maintained; bitter gourd (eight lines) was added and tomato and Chinese cabbage updated (eight lines) in the catalog in 2014. The group managed the Center's mature technologies database and training documents on the intranet to facilitate use by AVRDC staff. GTD also responded to many information requests worldwide.

A fertigation research project funded by the Taiwan Council of Agriculture continued; computerized fertigation systems from Taiwan and Israel are being compared for cost-effectiveness. The group's scientists also supported other projects, including the CGIAR Humidtropics program, the SDC-funded Vegetables Go to School, ACIAR-funded projects in Oceania and SATNET (Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia).

Global Technology Dissemination facilitated administrative issues and logistics for 72 trainees (43 women and 29 men) from 17 countries for capacity building activities at headquarters and provided guidance for training in the regions.



THE NUMBERS TELL THE STORY: In 2014, the Center carried out 171 training activities in 14 countries, reaching a total of 12,307 beneficiaries—61% female, 39% male. What did they learn? How to save and multiply vegetable seed. How to raise healthy seedlings. How to plant and maintain home gardens. How to train trainers! How to graft tomatoes, identify natural enemies, prepare starter solution to get crops off to a good start, build solar dryers and zero energy cooling chambers, build rain shelters to protect crops, produce high-value vegetables in the off-season, try new crops such as vegetable soybean and bitter gourd, grow a garden in bags, and cook and preserve vegetables for taste, appeal, and above all, nutrition. "We back up our capacity building activities with extension materials," said **Greg Luther**, Head, Global Technology Dissemination. "Our researchers produced leaflets, brochures, booklets, posters, videos, calendars and other tools to ensure that stakeholders have the resources and knowledge at hand to apply improved technologies after the training ends." It's all on the AVRDC website: http://avrdc.org

PLACE YOUR ORDER: Researchers, students, governments, community organizations, and individuals all have one thing in common: from time to time they need seed and advice, which AVRDC – The World Vegetable Center is happy to share. "In 2014, we added eight elite bitter gourd lines and one additional processing/dual purpose tomato line to the Center's online seed catalog," said **Mandy Lin**, Associate Specialist in Global Technology Dissemination. "It's a simple matter to fill out the seed order form and try these improved vegetable lines." Center scientists also prepared how-to guides for international research cooperators: Procedures for Sweet Pepper Variety Field Trials and Procedures for Chili Pepper Variety Field Trials are available for download on the AVRDC website, complete with blank data spreadsheets for ease of use.

Information Technology Services

Information Technology installed external storage for the volumes of data that have been generated and which continues to grow and must be archived. The group has extended wireless connectivity to previously uncovered regions within the headquarters campus.

Information Technology followed up on the announcement that was made in the last quarter of 2013 regarding the Microsoft Windows XP end-of-support, and worked with regional offices to migrate to more secure Windows 7 and Windows 8 platforms. IT worked with regional staff and external service providers to keep the Center's information systems safe and secure, and standardized anti-virus software where possible to achieve this ongoing objective. Staff have been sharing information on data security with Information Technology, which is assessed and shared when appropriate across the Center.

VegOne, the Center's database for collecting data against institutional indicators, has collected over 900 records on Center and donor indicators. A centralized database system proposed as "VegOneX" is being introduced in Tanzania to strengthen the linkages among various actors in the seed and produce supply chain.

Information Technology worked with the Biotechnology group to support them in their specific software and hardware requirements.

Information Technology has continued a strategic relationship with key software vendors for savings in software purchases in excess of US $20,000 on the full market value. The team's contribution to promote online meetings includes tools that allow individuals to collaborate, irrespective of their geographical locations and the devices they use, to participate in online discussions that can be recorded and share documents with other participants.

Information Technology has been working in collaboration with the Eastern and Southern African regional office on staff and infrastructure needs, and has provided training on general productivity software to staff, students and interns that visit the Center.

DATA COLLECTION IMPROVED: Data entered into VegOne, a Center-wide database for recording monitoring and evaluation information for the Center's indicators, is used for comparative analyses and reports. "We launched VegOne in 2013 and it continues to gain acceptance with our researchers as it evolves with new features and enhancements," said IT Manager Bharath Krishnan (*right*, with Agricultural Economics Postdoc Srinivasulu Rajendran). "It's an important tool for tracking the Center's progress over time." Researchers enter information about technologies developed and disseminated, publications, and other factors to aid in the evaluation of the impact and value of projects and interventions.

Grants and Partnership Development

The overall goal for Grants and Partnership Development is to be an effective and efficient institutional support function for the research and development agenda of AVRDC in terms of resource mobilization and project administration. In 2014 this was realized mainly through donor intelligence, quality review (proposals, technical reports, contracts), drafting of contracts, facilitation and coordination and in doing so, acting as a focal point for the Center for resource mobilization and project administration. Grants and Partnership Development participated in and contributed to Global Theme Meetings.

Grants and Partnership Development consists of two staff and its work in 2014 was mainly in three areas:

i. Facilitate, coordinate and support resource mobilization efforts: donor intelligence and priorities; review, edit and submission of concept notes and proposals; development of partnerships.

ii. Monitor and support project administration: negotiate, draft, review and edit contracts; review, edit and submission of technical reports; solving a multitude of other project-specific issues.

iii. Development and management of tools for resource mobilization and project administration.

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

In 2014, 53 concept notes and proposals were reviewed, edited and submitted to a multitude of donors. As of March 2015, 28 were funded, 8 rejected, 5 dropped (mainly due to lack of time by the lead writer) and 12 are pending.

Eighty-nine technical project reports to donors and partners were reviewed, edited and submitted.

All agreements that the Center signs with project donors and partners (currently the Center collaborates with more than 170 partners across the globe) pass through Grants and Partnership Development. The office supports negotiations and prepared, reviewed and edited numerous agreements.

The Center is in good financial health thanks to proper financial planning, resource allocation, monitoring and reporting. A significant and increasing portion of the Center's revenue comes from (restricted) project financing. The Center includes in all project proposals the full cost of the proposed actions to guarantee long-term financial sustainability.

Financial Services

	AVRDC	CGIAR** recommended range
Cash management on restricted operations*	0.4	less than 1
Adequacy of reserves	126 days	75-90 days
Short-term solvency	171 days	90-120 days

The Center has strengthened its financial reserves as part of its risk management strategy. Reserves have been set aside to provide a cushion against unexpected setbacks; to carry out necessary capital investment replacements; and to pursue innovative research ideas through the Innovations Fund.

2014 Revenues (in '000 USD)		
Unrestricted grants	8,817	46%
Restricted grants	10,268	53%
Other revenues	259	1%
Total	**19,344**	100%

Unrestricted Grants	
Republic of China (ROC)	4,714
UK Department for International Development (UK/DFID)	2,479
United States Agency for International Development (USAID)	1,000
Germany	313
Thailand	148
The Philippines	100
Korea	50
Japan	13
Sub-total	***8,817***
Other revenues	259
Total	**9,076**
Restricted Grants	
United States Agency for International Development (USAID)	4,343
Republic of Germany / BMZ / GIZ	1,617
Australia/Australian Centre for International Agricultrual Research (ACIAR)	1,048
Consultative Group on International Agricultural Research (CGIAR)	852
Swiss Development Cooperation (SDC)	579
Republic of China / Council of Agriculture	390
Republic of China / Ministry of Foreign Affairs	303
European Union	184
West and Central African Council for Agricultural Research and Development (CORAF/WECARD)	179
Korea/Rural Development Administration (RDA)	123
Republic of China / Ministry of Science and Technology (MOST)	95
COFRA Foundation	75
Asia and Pacific Seed Association (APSA)	73
Government of Karnataka	61
Alliance for Green Revolution in Africa (AGRA)	57
Volkswagen Stiftung Foundation	37
Kagome Co., Ltd.	25
Others	226
Sub-total	***10,268***
Total Revenues	**19,344**

IN FOCUS

GREEN@AVRDC

The Center's green initiative focuses on the conservation of environmental resources and reduction in the use of materials and services that contribute to environmental degradation. The Center has adopted an environment management policy that provides guidelines for monitoring, planning and implementing measures to reduce its carbon footprint.

About 70% of the Center's carbon footprint comes from electricity consumption, 20% through travel, and the rest from fuel, water and solid waste. By monitoring the use of electricity, fuel, water and generation of wastes, and putting appropriate reduction measures in place, the Center has reduced emissions of greenhouse gases considerably from 2011 levels. The cumulative reduction in electricity consumption since 2010 is about 750,000 KWH (kilowatt hours), which reduced the Center's carbon footprint by 470 metric tonnes of CO2 and saved about US$82,000. In 2014, conservation efforts at headquarters and AVRDC West and Central Africa reduced electricity consumption by 32,000 KWH, equivalent to 80-90% of the annual consumption of one regional office.

"Green Champions" at headquarters and in the regions collect and analyze data, monitor activities, replace obsolete and energy inefficient equipment, and meet periodically to discuss measures and recommend changes in systems and behavior. In 2015, the teams will expand their conservation work to review and to improve the efficiency of the glasshouses and irrigation systems.

(*above right*) Planting trees offset carbon use by about 800 kilograms a tree per year. Covering planting soils conserves water (by about 30%) and also reduces energy use.

(*below*) Composting leaves, stalks and other crop waste at headquarters. The compost is sifted, graded and returned to the fields to enrich the soil.

Staff

Diverse and strong

In 2014, AVRDC - The World Vegetable Center staff members came from 30 countries, including Taiwan. Women occupy 30% of the 66 senior staff positions.

30 countries including Taiwan

Senior Staff **65**

Women (30.76%) **20**

Staff Name	Position Title	Location	Nationality
Acedo, Jun[2]	Postharvest Specialist	Hyderabad, India	Philippines
Afari-Sefa, Victor	Scientist - Socioeconomics and Global Theme Leader - Consumption	Arusha, Tanzania	Ghana
Ahmad, Shahabuddin	Vegetable Sector Leader (Bangladesh)	Dhaka, Bangladesh	Bangladesh
Ali, Mansab	Horticulture Project Leader (AIP Pakistan Project)	Islamabad, Pakistan	Pakistan
Beed, Fenton[2]	Regional Director, East and Southeast Asia	Bangkok, Thailand	United Kingdom
Bidogeza, Jean-Claude[2]	Socioeconomist (Humidtropics Project)	Yaoundé, Cameroon	Burundi

Staff Name	Position Title	Location	Nationality
Caltagirone, Cristina[2]	Training Specialist	Shanhua, Taiwan	USA
Chang, Jan	Postdoctoral Fellow - Molecular Entomology	Shanhua, Taiwan	Taiwan
Chang, Rollen	Manager - Technical Services	Shanhua, Taiwan	Taiwan
Chang, Yin-Fu	Deputy Director General - Administration & Services	Shanhua, Taiwan	Taiwan
Chen, Huei-Mei[1]	Associate Specialist, Biotechnology/Molecular Breeding	Shanhua, Taiwan	Taiwan
Chen, Willie	Assistant Specialist, Global Technology Dissemination	Shanhua, Taiwan	Taiwan
Cho, Myeong-Cheoul[1]	Scientist - Pepper Breeding (seconded scientist from RDA/Korea)	Shanhua, Taiwan	Korea
Dhillon, Narinder	Vegetable Breeder - Cucurbits	Bangkok, Thailand	India
Dinssa, Fekadu Fufa	Vegetable Breeder	Arusha, Tanzania	Ethiopia
Diwani, Thuweba[2]	Project Manager, Systems Agronomist	Bamako, Mali	Kenya
Dubois, Thomas	Regional Director, Eastern and Southern Africa	Arusha, Tanzania	Belgium
Easdown, Warwick	Regional Director, South Asia	Hyderabad, India	Australia
Ebert, Andreas	Genebank Manager and Global Theme Leader - Germplasm	Shanhua, Taiwan	Germany
Fleissner, Klaus[2]	Agronomist/Breeder - Vegetable Cropping Systems	Yaoundé, Cameroon	Namibia
Gautam, Shriniwas	Postdoctoral Scientist - Monitoring and Evaluation	Bangkok, Thailand	Nepal
Ha, To Thi Thu[2]	Horticulturalist and Project Coordinator (Humidtropics Project)	Hanoi, Vietnam	Vietnam
Hanson, Peter	Plant Breeder (Tomato and Indigenous Vegetable Research), Global Theme Leader - Breeding	Shanhua, Taiwan	USA
Holmer, Robert[1]	Regional Director, East and Southeast Asia	Bangkok, Thailand	Germany
Hong, Yoonpyo[2]	Postharvest Specialist (seconded scientist from RDA/Korea)	Shanhua, Taiwan	Korea
Hsu, Sylvia	Manager - Food and Dormitory Services	Shanhua, Taiwan	Taiwan
Hughes, Jacqueline d'Arros	Deputy Director General - Research	Shanhua, Taiwan	United Kingdom
Inukonda, Nagaraj	Director of Human Resources	Shanhua, Taiwan	India
Iramu, Ellen	Project Coordinator - Pacific Islands	Honiara, Solomon Islands	Solomon Islands
Keatinge, J.D.H.	Director General	Shanhua, Taiwan	Ireland
Kenyon, Lawrence	Plant Virologist	Shanhua, Taiwan	United Kingdom
Krishnan, Bharath	Manager - Information Technology Services	Shanhua, Taiwan	India
Kumar, Sanjeet	Scientist - Pepper Breeding	Shanhua, Taiwan	India
Kwazi, Nadine	Executive Assistant to the Regional Director, Eastern and Southern Africa	Arusha, Tanzania	Zambia
Ledesma, Dolores	Board Secretary and Biometrician	Shanhua, Taiwan	Philippines
Lin, Chih-Hung	Associate Specialist, Bacteriology	Shanhua, Taiwan	Taiwan
Lu, Vincent	Internal Auditor	Shanhua, Taiwan	Taiwan
Luther, Greg	Technology Dissemination Specialist	Shanhua, Taiwan	USA
Luther, Kartini	Assistant to Deputy Director General - Research	Shanhua, Taiwan	USA

Staff Name	Position Title	Location	Nationality
Ma, Chin-Hua[1]	Associate Specialist, Bacteriology	Shanhua, Taiwan	Taiwan
Macharia, John	Project Manager (Income and Nutrition through Vegetables Project)	Arusha, Tanzania	Kenya
Mak, Adrienne	Manager - Management Support & Human Resources Services	Shanhua, Taiwan	Taiwan
Manickam, Ravishankar	Research Site Coordinator	Jharkhand, India	India
Mariyono, Joko	Project Site Coordinator (Indonesia)	Jawa Timur, Indonesia	Indonesia
Mavlyanova, Ravza	Regional Coordinator for Central Asia and the Caucasus	Tashkent, Uzbekistan	Uzbekistan
Mecozzi, Maureen	Head - Communications and Information	Shanhua, Taiwan	USA
Nair, Ramakrishnan	Vegetable Breeder - Legumes	Hyderabad, India	India
Nenguwo, Ngoni	Postharvest Specialist	Arusha, Tanzania	Zimbabwe
Öberg, Annelie	Manager - Grants and Partnership Development	Shanhua, Taiwan	Sweden
Overweg, Dirk	Director of Finance	Shanhua, Taiwan	The Netherlands
Palaniswamy, Usha	Project Manager (Vegetables Go to School Project)	Shanhua, Taiwan	USA
Pottorff, Marti[2]	Postdoctoral Fellow - Plant Pathology	Shanhua, Taiwan	USA
Rajendran, Srinivasulu	Postdoctoral Scientist - Agricultural Economics	Arusha, Tanzania	India
Rakha, Mohamed[2]	Postdoctoral Fellow - Tomato Breeding	Shanhua, Taiwan	Egypt
Ramasamy, Srinivasan	Entomologist	Shanhua, Taiwan	India
Rouamba, Albert	Vegetable (Onion) Breeder	Bamako, Mali	Burkina Faso
Schafleitner, Roland	Head - Molecular Genetics	Shanhua, Taiwan	Austria
Schreinemachers, Pepijn	Agricultural Economist	Shanhua, Taiwan	The Netherlands
Stoilova, Tsvetelina	Scientist - Genetic Resources	Arusha, Tanzania	Bulgaria
Tenkouano, Abdou	Regional Director, Africa	Bamako, Mali	Burkina Faso
Tignegre, Jean-Baptiste[2]	Vegetable Breeder	Bamako, Mali	Burkina Faso
Tsai, Wen-Shi[1]	Associate Specialist, Virology	Shanhua, Taiwan	Taiwan
Wang, Jaw-fen	Plant Pathologist and Global Theme Leader - Production	Shanhua, Taiwan	Taiwan
Yang, Ray-yu	Nutritionist	Shanhua, Taiwan	Taiwan
Yeboah, Martin[2]	Scientist (Vegetable Breeder & Horticulturalist), Liaison Officer for Cameroon	Yaoundé, Cameroon	Ghana

[1] Left in 2014
[2] Arrived in 2014

RESEARCH FOR DEVELOPMENT

In 2014, Center researchers shared their knowledge and results in international peer-reviewed journals, at conferences, and in partnership with scientists from developing countries.

36.5 Number of scientists

*Each internationally hired scientist counts as 1; the Director General, Deputy Director General – Research, Regional Directors, and Biometrician each count as 0.5. Scientists who leave the Center before the end of July are counted in the year's calculation. Newly recruited scientists are counted only if they joined the Center before the end of July.

2.36
Total externally reviewed publications per scientist
(journal articles, books, book chapters)

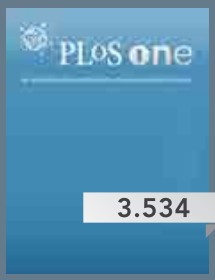
1.15
Publications per scientist in journals listed with Thomson Reuters

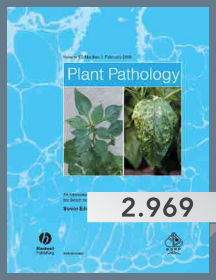
53.5%
Percentage of scientific papers in refereed journals and books published with partners from developing countries

25.6%
Percentage of scientific papers in refereed journals and books published with female authors from developing countries

TOP10 Journals

The top 10 journals (rated by Thomson Reuters impact factors) in which Center researchers published in 2014





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Acronyms & Abbreviations

AARNET	ASEAN-AVRDC Regional Network
ACIAR	Australian Centre for International Agricultural Research
AGRA	Alliance for a Green Revolution in Africa
AIFSRC	Australian International Food Security Research Centre
AIP	Agricultural Innovations Program
AIRCA	Association of International Research and Development Centers for Agriculture
APSA	Asia and Pacific Seed Association
ASEAN	Association of Southeast Asian Nations
AVGRIS	AVRDC Vegetable Genetic Resources Information System
BARI	Bangladesh Agricultural Research Institute
BEAF	Advisory Service on Agricultural Research for Development
BMZ	Federal Ministry for Economic Cooperation and Development/Society for International Cooperation
BPH	Best Practice Hub
CATIE	Tropical Agriculture Research and Higher Education Center
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIM	Center for International Migration and Development
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CMS	Cytoplasmic male sterility
COA	Taiwan Council of Agriculture
CORAF/ WECARD	Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles / West and Central Africa Council for Agricultural Research and Development
DFID	UK Department for International Development
EPA	Environmental Protection Administration
EPMR	External Program and Management Review
ERP	Enterprise resource planning system
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GIZ	Gesellschaft für Internationale Zusammenarbeit
GRSU	Genetic Resources and Seed Unit
GTD	Global Technology Dissemination

HKI	Helen Keller International
HortCRSP	USAID Horticulture Collaborative Research Support Program
HQ	Headquarters
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IER	Institut d'Economie Rurale
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture
ILRI	International Livestock Research Institute
IP	Intellectual property
IPM	Integrated pest management
IRRI	International Rice Research Institute
IVTC	International Vegetable Training Course
KU	Kasetsart University, Thailand
KWH	Kilowatt hours
MOFA	Taiwan Ministry of Foreign Affairs
NAC	National Agrobiodiversity Center
NARES	National agricultural research and extension systems
NGO	Nongovernmental organization
NPS	Neutralized phosphorous acid salt
NSC	National Science Council
PADFA	Projet D'Appui au Développement des Filières Agricoles
PARC	Pakistan Agricultural Research Council
PGS	Participatory guarantee systems
RDA	Rural Development Administration, Korea
SATNET	Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia
SDC	Swiss Agency for Development and Cooperation
SPC	Secretariat of the Pacific Community
UN-ESCAP	Economic and Social Commission for Asia and the Pacific of the United Nations
USAID	United States Agency for International Development
WACCI	West Africa Centre for Crop Improvement