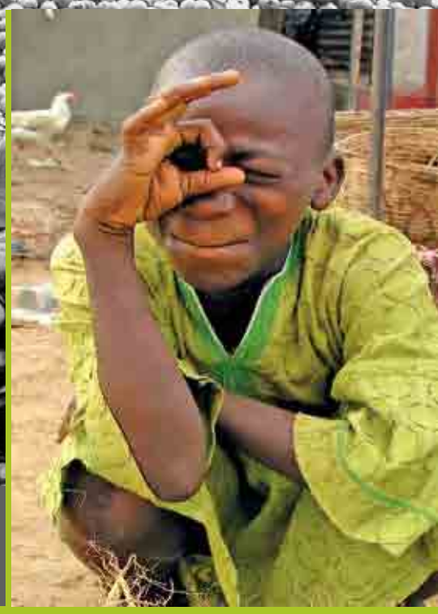

2007-2009

Medium-Term Plan

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AVRDC
The World Vegetable Center

AVRDC – The World Vegetable Center

2007- 2009

Medium-Term Plan

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The Center

AVRDC-The World Vegetable Center is the leading international not-for-profit research and development institute committed to ensuring food security and stronger economies through vegetable research, development and training.

Published by

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AVRDC – The World Vegetable Center
2007- 2009 MEDIUM-TERM PLAN

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Foreword

AVRDC - The World Vegetable Center is pleased to present its 2007-2009 Medium Term Plan (MTP). This MTP has fundamentally evolved in structure and function from the previous MTPs for 2003, 2004, and 2005 to conform to the norms of international agricultural research centers. The first three chapters describe the context of our Center. Chapter 1 reviews the global importance of vegetables and Chapter 2 restates our unique contribution. Chapter 3 then reviews the historical development of the Center, its regional expansion, commodity focus, budget development, and the refocusing of its expertise into five new themes.

Chapters 4 and 5 describe the structure and function of the Center and its regional programs. The Center is in the process of a major expansion that started four years ago and this has necessitated a new organizational structure which is described in Chapter 4. The regional programs have developed significantly over the last four years with a major new funding boost for Africa and the creation of the South Asian regional program. Chapter 5 discusses the priorities, implementation of the themes, infrastructure, and funding requirements of each regional program.

Chapters 6 and 7 provide details of the major project portfolio and the logframes for the Center's thematically-based global research and development work. The efforts of our global research staff fall within five research themes and have been apportioned accordingly to illustrate the extent and unity of the Center's activities. Chapter 6 provides an overview of the Center's nine largest donor-funded projects and Chapter 7 details the work plans and logframes for each theme.

Chapter 8 provides details of budgets and major partnership projects. The actual 2006 budget, the proposed 2007 budget and breakdown of funding sources, as well as the proposed budgets for 2008 and 2009 are included. The progressive change in how research funds are to be allocated between themes is also shown along with details of the Global Horticulture Initiative, a major new funding and promotion activity, spearheaded by the Center.

In the following pages, I am pleased to share with you our vision for the Center, which was developed with the input of our Center's staff and our networks of partners in the private and public sectors.

Thomas A. Lumpkin
Director General

1. The Global Context

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Vegetable production is expanding globally and over the past 25 years, has more than doubled. This increased production has largely resulted from expanded production areas in developing countries – particularly in Asia, and improved productivity growth in developed countries. China has emerged as the world leader in vegetable production with production growing over the last 20 years at an average of 8.7% per annum. The growth potential in much of the developing world remains untapped, with enormous opportunities for the future of vegetables.

If the potential contribution of vegetables to the Millennium Development Goals is to be achieved, a much higher investment in the sector is required. The availability and consumption of vegetables is unevenly distributed and the lowest levels of production and consumption are recorded for developing countries in sub-Saharan Africa. Limited yield improvements, high postharvest losses and low levels of vegetables consumed and processed in many parts of the world illustrate the need for greater investment in research and development. The neglect of the vegetable sector by policy makers and donors is impeding potential economic growth and is having devastating health effects. Each day, 300 mothers die in childbirth due to iron deficiency and 4000 children die from the effects of vitamin A deficiency (www.who.int). These micronutrient deficiencies can be remedied by an increased consumption of vegetables.

For much of the developing world, the greatest economic opportunities for vegetables are through expansion of diversity, seasonality, product appeal, competition, safety and postharvest handling in local and regional markets. The combination of increasing local and global demand for vegetables, insufficient consumption in most developing countries and the relative advantages of their labor costs, represents a very significant opportunity for growth in vegetable production and improved health in developing countries. In many regions however, small producers are often excluded because they fail to understand market dynamics and are unable to conform to new production, sanitary, and quality standards.

Assuring food safety is critical to successful marketing and the export of produce, misuse of pesticides and quality deterioration due to inappropriate harvest and postharvest operations lead to health risks and loss of product appeal. There needs to be a greater commitment to training, research, development, and training to support the supply chain and curtail the hazardous effects on human health and the environment.

Worldwide, the loss of biodiversity is leading to the loss of genetic material that could provide traits to enhance vegetable productivity through improved nutrition and tolerances to biotic and abiotic stresses. Degradation of forests and savannahs leading to the loss of wild relatives of crop plants, climate changes, and the loss of agrobiodiversity as farmers adopt a narrower range of improved varieties dictate that we must move quickly to improve the collection, preservation, and use of the world's vegetable genetic material.

The possible introduction of genetically modified (GM) crops is a reasonable consumer concern. GM technologies have the potential to complement traditional breeding approaches, but must be thoroughly tested for biosafety following appropriate policies to evaluate, handle, and release GM crops. Presently in the majority of developing countries, there is no regulatory system for GM crops and even most developed country regulatory agencies are poorly funded and/or compromised by political or social agendas. GM technologies offer revolutionary potential to reduce the impact of agriculture on the environment and improve human health but the public sector has failed to release a significant number of GM varieties, especially for traits ignored by the private sector, such as improved nutritional value, due to issues of biosafety, intellectual property rights (IPR), and regulatory hurdles.

Successful vegetable research should be based on the development of global programs which should include public-private partnerships with each partner having evolving, complementary, and compatible roles. This should include the creation of improved varieties, enhanced seed sectors, and appropriate management systems.

2. Our Unique Role

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Our mission

"To alleviate poverty and malnutrition in the developing world through the increased production and consumption of safe vegetables."

Our strategy

To build partnerships and mobilize resources from the private and public sectors to promote production and consumption of safe vegetables in the developing world.

Our research contributes to:

- Conservation and utilization of vegetable germplasm biodiversity;
- Genetic enhancement to increase productivity in the vegetable sector and improve sustainability of cropping systems;
- Environmentally-friendly seed and safe vegetable production;
- Postharvest management to increase market opportunities and economic development in favor of rural and urban poor; and
- Nutritional security and more diversified diets to improve health of low income families.

We rely on participatory approaches involving farmers and other stakeholders from project inception to completion. By evaluating needs together and jointly designing and developing a project, we help to ensure that project outcomes are more likely to be adopted.

3. Historical Context

The Center is going through a period of expansion and profound change as a result of increased and more diversified funding. New offices have been opened, new staff appointed, and the Center has made a fundamental shift from a relatively small regional institution to an increasingly recognized international research and development organization. In staffing and budget, as well as in its geographic coverage and unique mandate, the Center is now equivalent to one of the smaller centers of the Consultative Group for International Agricultural Research (CGIAR). Its growing global status is reflected in the launching of the Global Horticulture Initiative (GlobalHort) in 2005 and its leading role, with the CGIAR, in creating a Challenge Program for high value crops.

3.1 Expanding regional presence

AVRDC – The World Vegetable Center was founded in 1971 with a mandate to support vegetable research for development in Asia, with a particular emphasis on Southeast Asia. In the early 1990's, operations were expanded to sub-Saharan Africa, with some limited project work in Latin America. Regional offices in Bangkok, Thailand and Arusha, Tanzania were opened in 1992. Expansion slowed later in the decade as the budget declined, but since 2000 there has been one new regional office opened and several project offices have developed as funds allowed, many of which were co-located with CGIAR offices.

- 2000-2006 Hanoi, Vietnam: CIRAD funded project on sustainable urban and peri-urban vegetable production
- 2003-2005 Cote d'Ivoire: Collaborative work with WARDA – Africa Rice Center on vegetables in rice systems in West Africa
- 2004-present Tashkent, Uzbekistan: Work on vegetable germplasm collection and trials in conjunction with national partners
- 2005-present Bamako, Mali: West African work relocated to the ICRISAT campus in Bamako after closure of the WARDA offices in Côte d'Ivoire due to civil strife. The program expanded to include vegetable production in the Sahel
- 2004-2006 Jalalabad, Afghanistan: The development of trials of vegetables as an alternative to opium poppy production - in partnership with ICARDA, Relief International, and IDE
- 2006-present Regional Center for South Asia: This is based on the ICRISAT campus in Hyderabad to develop a regional program to focus on vegetable production for impoverished regions of the sub-continent
- 2006-2010 Vientiane, Laos: ADB funded project focusing on training and postharvest management of vegetables
- 2007 Niamey, Niger: Joint appointment of a plant breeder with ICRISAT to work on vegetables in cropping systems in the Sahel
- 2007 Madagascar, Cameroon, South Africa: Project offices associated with the Vegetable Breeding and Seed Systems project will be opened to provide regional hubs for vegetable seed development programs for different eco-regions of Africa

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In 2007, the Center is present at the following locations:

Headquarters

Shanhua, Taiwan

Regional centers

Asian Regional Center
Bangkok, Thailand

Regional Center for Africa
Arusha, Tanzania

Regional Center for South Asia
Hyderabad, India

Sub-regional offices
Bamako, Mali
Tashkent, Uzbekistan
Seoul, Korea

Offices
Vientiane, Lao PDR
Niamey, Niger

3.2 Changing commodity focus

The Center's mandate does not specify a set of core commodities and its crop portfolio has changed as global needs and its relative advantage changed. The shifting research programs of other international private and public agencies, particular staff skills and the availability of specific project funding have all influenced crop priorities.

The original focus of the Center was on tomato, mungbean, soybean, sweet potato, and Chinese cabbage. By the early 1990s, it had dropped sweet potato and focused the Center's research on three groups of global importance: solanaceous crops - tomato, peppers, and eggplant; bulb alliums - onion, shallot, and garlic; crucifers - cabbage and Chinese cabbage. Regional work focused on indigenous vegetables with significant support from Headquarters (HQ). Since 2000, the work on grain legumes, crucifers and bulb alliums has declined while the work on solanaceous crops (particularly tomato and peppers) and indigenous vegetables has expanded and a new cucurbit program was started in 2006.

3.3 Expanding budget over the last four years

During the 1990s, the Center's budget was fairly stable at around USD 10 million but declining in real terms. A more aggressive vision for serving the needs of the developing world over the last four years in particular, has attracted a near doubling of the Center's funding, with increased restricted core funding and contributions from the private sector. There has been a major renovation of Headquarters' research facilities, appointment of new staff, and a major expansion of project work in the regions – particularly in Africa. Although the host country government of Taiwan remains the Center's most important donor, there has been a substantial diversification of funding. Figure 1 below shows the changes in the Center's budget over its history, with projected funding for the planning period 2007-2009 also shown.

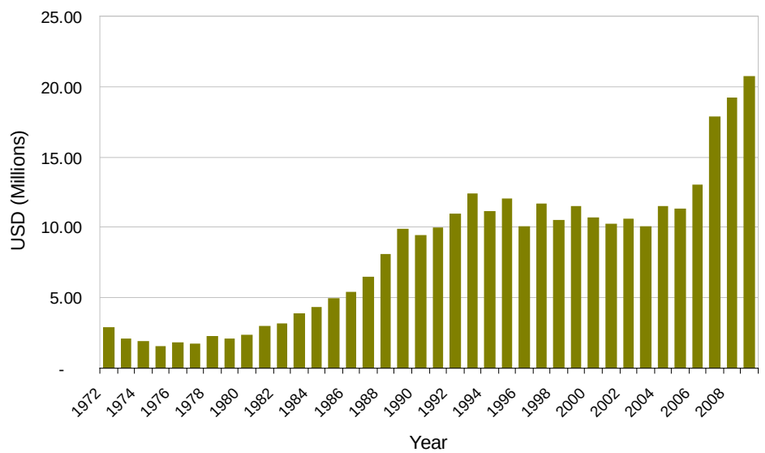

Figure 1. AVRDC–The World Vegetable Center revenues 1972–2006 and expected revenues 2007–2009

We expect that the trend for increasing funding for vegetable research and development will continue. The budget for 2007 is expected to be USD 17.8 million and the Center's management is optimistic that the financial growth will continue. In 2008, the budget is projected to be USD 19.2 million and USD 20.7 million by 2009. This conservative budget projection may be exceeded through enhanced collaboration with other CGIAR Centers on vegetable related research, and by increasing the number of scientists actively involved in proposal writing efforts.

Most increased funding will be for research and development activities in sub-Saharan Africa and South Asia, while increased funding for activities in Southeast and East Asia may be less dramatic.

3.4 Refocusing our core expertise

There has been some realignment over recent years, but the Center's core expertise has evolved slowly and is now encapsulated in its five new research themes and the ongoing communication and training work associated with their practical implementation. The themes cover the whole vegetable system from collecting germplasm to producing varieties, improving production and marketing to improving the nutritional value of vegetables.

- Theme 1: Germplasm conservation, evaluation, and gene discovery
- Theme 2: Genetic enhancement and varietal development of vegetables
- Theme 3: Seed and safe vegetable production systems
- Theme 4: Postharvest management and market opportunities
- Theme 5: Nutritional security, diet diversification, and human health

Each theme encapsulates both upstream and downstream research and development work with many public and private partners. This involves laboratory studies, field trials at locations around the world, participatory research and development work with National Agricultural Research and Extension Systems (NARESs), the private sector and farmers to develop appropriate technologies. The Center also has extensive training and promotion programs in conjunction with the public and private sectors to ensure widespread awareness and adoption of improved vegetable technologies.

4. Strategic Organization

Efforts to re-focus the Center over the last four years have led to the need to change the organizational structure to take better account of growing regional capacities and a more complex staffing structure. The following structure has been agreed on for implementation in 2007:

The Director General (DG) will continue to be responsible to the Board of Directors. Four 'units' will report directly to the DG, in addition to the Global Horticulture Initiative (GHI). These are:

- Internal Audit;
- Financial Services;
- Deputy Director General - Administration and Services (DDG-A&S); and
- Deputy Director General - Research (DDG-R).

The DDG-AS will be responsible for host country liaison for the Center and in the context of GHI. In addition, the DDG-AS will continue to have oversight of Headquarters administration and support services, specifically:

- Administrative Services;
- Food and Dormitory Services; and
- Technical Services.

The DDG-R will be responsible for global research and development activities of the Center under the DG.

The current oversight of the research activities will continue, however this process will become streamlined through thematic research. The five themes each have a Theme Coordinator and a Deputy who have oversight of the research activities within that theme. The Coordinator will have limited responsibility but the thematic research will be developed in such a way that the coordinator has sufficient authority to be able to coordinate the activities effectively and with minimum impact on their own research activities.

The important role of the Regional Directors in coordinating the thematic research in the regions through the Regional Centers and in performing their administrative functions will be strengthened as they coordinate sub-regional office activities and begin to integrate projects and themes offices into their respective regional visions.

The International Cooperation Office will be re-focused. It will provide oversight of some of the Center's international activities, for example, country memorandum of understandings (MoUs), responding to emergency needs where appropriate, oversight for donor relations and grant development, support the DG, DDG-A&S, and DDG-R in interactions with partners and collaborators, and support the development of multi-country networks, variety trials, and other activities.

To streamline, rationalize, and facilitate the needs, processes and procedures with respect to the Center's national and international staff in all the Center's global locations, a new Human Resources Manager will ensure transparency and equity in personnel issues.

Communications will continue to work closely with the Center's management to ensure that the vision of the center is portrayed accurately and that the products and impact of the Center are widely known. Communications has oversight of the computer, library and training services which are closely inter-linked with the thematic research and the needs of the regional centers.

The new, streamlined structure of AVRDC - The World Vegetable Center shown in Figure 2 will assist the leadership of the center and facilitate decision-making through delegation of responsibility and authority.

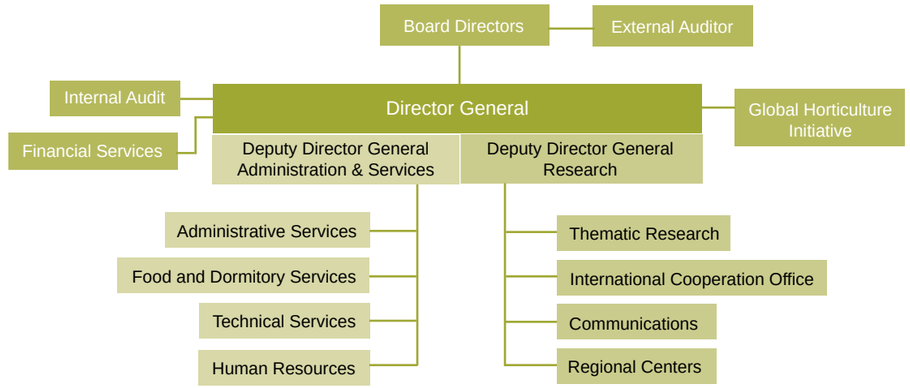

Figure 2. AVRDC–The World Vegetable Center proposed organizational structure

5. Regional Programs

5.1 Regional priorities

The three regional centers are at quite different stages of development and although they share the common vision of the Center as a whole, its implementation will differ depending on regional needs and the projects they develop. The regional programs are where most of the Center's development work are done, and to a significant extent the focus of each regional center is dictated by the nature of the grants they obtain since this provides the bulk of their funding. The Center's mission 'To alleviate poverty and malnutrition in the developing world through the increased production and consumption of safe vegetables' will therefore be emphasized in different ways in each region.

Africa
The African program has been in existence since 1992, with established training facilities at Arusha, a long history of work on indigenous vegetables, and growing sub-regional activities in West Africa. The Regional Center for Africa (AVRDC - RCA) has a good reputation for high quality research and for promoting improved indigenous and exotic vegetable varieties. It also has a large network of training alumni throughout Africa. It will aim to expand its research program in cooperation with African seed companies and universities in sub-Saharan Africa and worldwide, and to increase its impact and visibility through increased publications capacity throughout SSA. This will include writing up previous work and completing impact studies of past work. The research facilities for analytical work and plant breeding will also be strengthened.

The grant from the Bill and Melinda Gates Foundation for Vegetable Breeding and Seed Systems (vBSS) for poverty alleviation in Africa will have a very large impact on the work of AVRDC - RCA with strong emphases on variety development, seed systems, training, and development, and the opening of new offices in Madagascar, South Africa, and Cameroon. National breeding units (NBUs) are to be set up in four countries with expanded improvement of African indigenous vegetables (AIV).

A joint position co-funded with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and based in Niamey, Niger for a vegetable breeder is in place to maximize use of resources in ICRISAT and AVRDC - The World Vegetable Center.

Because per capita vegetable consumption is low in most of SSA, there will be a continuous need to raise the importance of vegetables in daily life and to stimulate the activities of policy makers and training and research institutions. The vBSS program will help expand training activities to cover farm and business management and to increasingly strengthen organizational capacity. The program will work with the public and private sectors to facilitate the development of a network of centers of excellence for applied horticultural research in Africa.

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East and Southeast Asia
The East and Southeast Asian program also began in Bangkok, Thailand in 1992 with a strong emphasis on training in conjunction with Kasetsart University. It faces very different challenges because most of the countries in the region are more developed. Long-term funding from the Swiss Development Center (SDC) has recently ended. Donors have changed their emphasis within Southeast Asia to focus on the poorest countries in the region, including Indonesia, Cambodia, Lao PDR, Vietnam, and Myanmar.

Developing countries in the region have either attained or are in the process of developing a good research and extension capacity, so the Asian Regional Center (AVRDC-ARC) must focus on enhancing the management skills of professionals involved in agriculture development through appropriate regional training. AVRDC- ARC will work with regional training and development organizations and seed associations to build the capacity of scientists, extensionists, farmers and consumers to maximize the potential of vegetables for nutrition and incomes in countries as diverse as Myanmar and Papua New Guinea, the People's Republic of China, and Indonesia. With support from an Asian Development Bank (ADB) grant, the training programs are continuing, and further projects are being sought to work with the poorest countries in the region.

Engagement with the private sector is being expanded to undertake collaborative and financed regional vegetable variety testing programs. In 2007, a regional assessment of seed industry impacts on small vegetable farms in South and Southeast Asia is being done. Other options being considered for further collaboration in 2008 and 2009 include a program for the abatement of pesticide abuse in vegetable crops and a collaborative program for insect management in brassicas for Asia.

Economic development is raising concerns about the loss of biodiversity within the region and the heritage of indigenous communities. The Center aims to tap into a regional policy interest in the Association of Southeast Asian Nations (ASEAN) countries in protecting and promoting indigenous vegetables as a part of preserving the region's biodiversity and protecting its indigenous communities. This will involve working with regional and international agencies to empower farmers and communities to play a greater role in conservation and utilization of indigenous vegetables.

There is also a need to improve the production of safe vegetables. A major thrust of AVRDC-ARC in collaboration with ASEAN is to promote the adoption and understanding of advanced vegetable production techniques in line with Good Agricultural Practices (GAP). This will also involve the development of participatory approaches to inform poor communities in more efficient vegetable production to improve the utilization and marketing of more nutritious vegetables in the Greater Mekong Subregion (GMS).

5.2 Regional thematic emphases

The detailed regional implementation of the global themes is covered in Chapter 7. Only the major regional emphases are shown here:

	AFRICA	SOUTHEAST ASIA	SOUTH ASIA
Theme 1 Germplasm conservation, evaluation, and gene discovery	• Conservation, characterization, and evaluation of collected indigenous vegetable (IV) germplasm and select tomato, onion, peppers, vegetable soybean, eggplant, and mungbean germplasm • Screening of stored germplasm for disease resistance	• Continue collaboration with Kasetsart University on promoting germplasm conservation and evaluation	• Collection, conservation and evaluation of indigenous vegetables and selected exotic vegetable crops of importance to the region
Theme 2 Genetic enhancement and varietal development of vegetables	• Start a shuttle breeding program for vegetables of regional priority with Headquarters. Purify collected IV lines and select appropriate exotic vegetable varieties coming out of the Headquarters' breeding program • Multiply the seeds of pure lines and work with regional seed companies and relevant research institutes for multiplication and commercialization	• Develop new partnership with Chinese institutions on collection, characterization, molecular fingerprinting of selected indigenous vegetables. • Breeding mungbean for bigger seeds and disease tolerance at the AVRDC-ARC field station	• Identification of suitable lines to share with the national partners for adoption, multiplication, distribution and utilization

South Asia

The South Asian program only started in 2006 and will focus on areas with the highest poverty levels and will cover countries from Afghanistan to Bangladesh, Nepal to the Maldives. Because the Regional Center for South Asia (AVRDC-RCSA) is located at ICRISAT's headquarters, there is likely to be more interaction with the CGIAR Centers in this region than has been the case in the other regions. There will be a strong emphasis on building networks with the already substantial public and private sector organizations active in seed and vegetable production in the region. Its aim is to bring about improved rural livelihoods, increased food and nutritional security through sustainable safe vegetable production and utilization in the region. Further expansion of activities through funding from private foundations in India may boost AVRDC-RCSA activities.

Central and West Asia and North Africa

Negotiations have been concluded to place an olericulturalist/horticulturalist and economist at the International Center for Agricultural Research in Dry Areas (ICARDA) headquarters in Aleppo, Syria to serve the regions of Central and West Asia and North Africa. These placements will be co-funded with initial support from Canada. Research is likely to focus on irrigated vegetable production, often under protected conditions, as well as the economics of vegetable production and water conservation.

Latin America

Negotiations to establish a presence in Latin America began in 2005 following identification of needs for Latin America by the Global Horticulture Assessment (http://caes.ucdavis.edu/IntProg/Global.htm). Discussions to establish a Regional Center for Latin America (RCLA) are continuing with institutions in Central America. Once finalized, and if financial support is obtained, it is expected that an economist, horticulturalist, breeder and plant pathologist could be employed over 2008 and 2009 to meet the needs of the region's poorest communities which have already been identified. Negotiations are also continuing to expand the Center's collaborative efforts with the International Potato Center (CIP) in Peru on synteny between the genomes of solanaceous crops related to the genes for disease resistance.

	AFRICA	SOUTHEAST ASIA	SOUTH ASIA
Theme 3 Seed and safe vegetable production systems	• Develop integrated pest management (IPM) practices to reduce pesticide use and enhance availability of safe vegetables for consumption • Introduce and promote lines of IVs resistant to pests and diseases to encourage safe vegetable production • Study disease resistance mechanisms especially in IVs to help design better breeding projects • Training in seed production	• Fruitfly management with new techniques that are less polluting • Understand the impact of natural biological control of legume podborer, *Maruca vitrata* • Conduct regional workshops and training to address education of resource poor farmers in safe and sustainable vegetable production, including GAP	• Identification of good agriculture practices for quality seed production and increasing yield and quality aspects of vegetable crops in the region
Theme 4 Postharvest management and market opportunities	• Expand research to better understand all aspects of the African IV supply chain • Continue to promote adoption of new varieties and to help link farmers to markets • In collaboration with partners, develop a market information system (for national and regional export of vegetable products)	• Empower farmers through training to address market opportunities and develop skills to produce innovative tools for use and sale	• Knowledge sharing and capacity building on new approaches and methodologies through training and user friendly information management
Theme 5 Nutritional security, diet diversification and human health	• Research to establish the importance of exotic vegetable and indigenous vegetables in alleviating food security problems in the region • Promoting vegetable consumption and improved processing • Vegetable lines with high nutrient contents will be selected for promotion and varietal development • Develop and promote new recipes to provide high bioavailability of nutrients for all major indigenous vegetables to improve the diets of urban and rural communities	• Continue study of biochemical functionalities of selected indigenous vegetables under a new phase of collaboration between Japan International Research Center for Agricultural Sciences (JIRCAS), AVRDC-ARC, and Kasetsart University	• Promoting urban and peri-urban vegetable production and marketing for income generation for nutritional security, diet diversification and human health

6. MAJOR PROJECTS

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The Center's current eight largest projects range in size from approximately USD 12 million down to USD 0.35 million and are the major sources of funding for our regional work as well as general research and development support.

1. Vegetable breeding and seed systems for poverty reduction in Africa

Funded by
Bill & Melinda Gates Foundation

Total budget
USD 12,083,990

Budget for AVRDC
USD 12,083,990

Project duration
December 2006 - November 2009

AVRDC staff involved
Jackie Hughes (Deputy Director General – Research), Detlef Virchow (Director, AVRDC - Regional Center for Africa), Ekow Akyeampong (Coordinator, AVRDC – Sub-Regional Office for West and Central Africa), Peter Hanson (tomato and crucifer breeder), Paul Gniffke (bulb *Allium* and pepper breeder), Robert de la Peña (Molecular Plant Breeder), Warwick Easdown (Head, Communications), Oliver Hanschke (Information and Media Associate), other disciplines as appropriate: bacteriology, biotechnology, crop & ecosystem management, entomology, genetic resources and seed, mycology, nutrition, socio-economics, and virology

Partner institutes
Cameroon National Breeding Unit; Madagascar NBU; Mali NBU; Tanzania NBU (NBU includes AVRDC, the private sector, and the national agricultural research and extension systems)

Executive summary
To increase vegetable production, marketing, and consumption and foster rural development in order to reduce poverty and improve livelihoods of vulnerable groups, particularly poor women and children in sub-Saharan Africa.

To meet the project purpose and capitalize on the economic potential of vegetables in sub-Saharan Africa, the project will form bases in each of the four major agro-ecological zones of SSA, breed introduced and indigenous vegetable varieties for/to:

- Pest and disease resistance;
- Tolerance to the abiotic stresses of drought and heat;
- Low requirement for inputs such as pesticides and fertilizers;
- High economic yield;
- Appropriate characteristics to meet consumer preferences;
- High micronutrient content;
- Test and multiply the most promising lines;
- Disseminate the outstanding varieties; and
- Undertake demand creation activities to ensure widespread adoption.

To enhance vegetable varieties for SSA, the project will:

- Develop national breeding units in four hub countries;
- Build vegetable seed system capacity in both the hub and neighboring 'spoke' countries; and

- Network the national vegetable breeding programs, private African seed companies, and vegetable seed supply systems in the hub and 'spoke' countries; and promote increased and sustainable vegetable production, marketing, and consumption in the hub and 'spoke' countries.

2. AVRDC-ARC human resource development for the Mekong Region, Phase IV

Funded by
Swiss Agency for Development & Cooperation (SDC) for the Mekong Region

Total budget
USD 1,601,000

Project duration
April 2003 – May 2007

AVRDC staff involved
Peter Ooi (Director, AVRDC-Asian Regional Center), Ma. Doreen Canillas (Assistant Project Coordinator), and Efren Altoveros (Training Consultant)

Partner institutes
Research Institute of Fruits and Vegetables, Vietnam; Hue University of Agriculture and Forestry, Vietnam; Institute of Agricultural Science, Vietnam; Ministry of Agriculture and Forestry, Lao PDR; and Myanmar Agriculture Service, Myanmar

Executive summary
In the upland and remote rural areas of Vietnam, Lao PDR, and Cambodia, there are a number of specific problems and needs in the vegetable sector. These include: limited knowledge on vegetable growing and consumption patterns and on new vegetable crops, varieties, and management techniques adapted to the local situation; few well-organized extension services that reach poor farmers and a lack of professional technicians and extensionists who are able to work with farmers on vegetable production; poor knowledge on marketing of vegetables and insufficient knowledge on seed multiplication and storage; and weaknesses in information networking among countries, researchers, and extension.

In accordance with government policies in the three countries, this project will have an emphasis on poverty reduction in remote rural and upland areas. The orientation towards training and research will remain, but the project will increasingly focus on having an impact on consumption and incomes for poor producers in these areas. This implies stronger research-extension linkages and a greater focus on women producers because they are often the main players in vegetable production and marketing.

The overall goal is to reduce poverty and improve the nutritional status of farming households in the poorest rural areas in Vietnam, Lao PDR, and Cambodia. Increased vegetable production and consumption among participating households would be a significant contributory factor to reducing poverty and improving nutritional status in the project target areas. The specific project goal is to

increase income from vegetable production and consumption of vegetables by farming households in upland and remote areas of Vietnam, Lao PDR, and Cambodia.

The project has four main objectives that relate to the main outputs and capacity building activities in training, research, extension and networking between the partner institutions and other agencies. The project objectives are to:

- Increase capacities of researchers of the five national partner institutions to conduct relevant, need-based vegetable research for farmers in upland and remote areas;
- Increase capacities of selected agricultural extension institutions to define and use improved vegetable production, processing, and marketing techniques and deliver need-based effective extension services;
- Benefit farmers in uplands and remote areas from improved vegetable production, processing, and marketing techniques imparted by lead farmers; and
- Strengthen institutional knowledge and information sharing on vegetable production, processing, and marketing for poor areas of the Mekong region.

3. Promotion of Neglected Indigenous Vegetable Crops for Nutritional Health in Eastern and Southern Africa (Phase II)

Funded by
Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)/Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)

Total budget
EUR 1,050,000 (USD 1,360,800)

Budget for AVRDC
EUR 665,576 (USD 862,586)

Project duration
March 2006 – February 2009

AVRDC staff involved
Detlef Virchow (Director, AVRDC-Regional Center for Africa), Mel Oluoch (Training Coordinator), Drissa Silué (plant pathologist), Liwayway Engle (Geneticist), Katinka Weinberger (socio-economist), Manuel Palada (crop and ecosystem management specialist), and Ray-yu Yang (nutrition specialist)

Partner institutes
Bioversity International; Rwanda Institute of Agriculture Research, Rwanda; Kawanda Agricultural Research Institute, Uganda; Uganda Martyrs University, Uganda; Horticultural Research Institute, Tanzania; Bvumbwe Agricultural Research Station, Malawi; and Georg-August-University of Goettingen, Germany

Executive summary
The goal of the project is to improve household food security of resource-poor groups in Eastern and Southern Africa by 1) safeguarding biodiversity of indigenous vegetables; 2) reducing malnutrition and poverty among small-scale farmers and consumers through promotion, production, and consumption of IVs; and 3) diversifying and stabilizing farmers' income and nutritional health through higher quality seed and improved cultivation practices of IV crops.

The targeted countries are Rwanda, Uganda, Malawi, and Tanzania. Private sector, farmers and consumers will be the immediate beneficiaries because the final expected outputs are easy availability of seeds of superior micronutrient-rich indigenous vegetable lines and improved farm practices. The project outputs will benefit the urban and rural poor. Since the farmers engaged in the production of indigenous vegetable crops are mainly women, they will be the first to reap the benefits from this project. With improved vegetable varieties available on the table, more consumers will benefit from the nutritious food, which would make a major contribution to their health. Other beneficiaries include NARES, private sector, and non-government organizations (NGOs). AVRDC and its partners will link with local seed producers and private sector to improve the production, marketing, and consumption of IVs.

The project will create an enhanced genetic resource base, improve technology dissemination, and produce and distribute improved seed of IVs to safeguard biodiversity for better health, nutrition, and improved income.

The expected outputs include:

- Breeder's lines and quality seed of promising IV varieties available for multiplication and distribution to farmers and seed producers;
- Improved cultivation practices for selected IV crops identified and made available to target groups;
- Nutrients, phytochemicals, and potential health-related factors including antioxidant and anti-microbial compounds measured and identified;
- Economic studies to understand constraints in the supply chain and to assess the success of the project conducted;
- Capacity building, training and information with emphases on cultivation practices and seed production on indigenous vegetables conducted; and
- Networking and partnership among scientists strengthened.

4. Application of molecular markers to broaden the genetic base of tomato for improved tropical adaptation and durable disease resistance

Funded by
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)

Total budget
EUR 1,510,000 (USD 2,064,844)

Budget for AVRDC
EUR 1,114,165 (USD 1,523,553)

Project duration
March 2004 – September 2009

AVRDC staff involved
Peter Hanson (plant breeder), Jaw-fen Wang (plant bacteriologist), Sylvia Green (plant virologist), Ray-yu Yang (nutrition specialist), Dolores Ledesma (biometrician)

Partner Institutes
Indian Institute of Horticultural Science, India; Indian Council Agricultural Research, India; Tropical Vegetable Research Center, Kasetsart University, Thailand; National Center for Genetic Engineering Biotechnology, Thailand; University of Hannover, Germany

Executive Summary
The project goal is to increase incomes of rural and urban poor in South/Southeast Asia through better-adapted tomato cultivars that improve productivity for the hot humid lowland tropics.

The project purpose is (1) to improve heat tolerance, yield, and multiple disease resistance of tropical tomato cultivars through application of molecular marker techniques that permit effective exploitation of wild species and (2) to make materials available for the use of NARES and the private sector and the adoption by vegetable farmers.

Molecular marker technology facilitates development of tomato cultivars with durable disease resistance through the pyramiding of multiple resistance genes and permits tomato breeders to effectively identify beneficial genes in wild tomato (*Lycopersicon*) species and rapidly backcross them into elite cultivars. The project will:

- Identify and develop user-friendly molecular markers linked to genes conditioning resistance to two tropical tomato diseases (bacterial wilt and whitefly-transmitted geminiviruses) and use those markers to pyramid multiple disease resistance genes into elite tomato cultivars;
- Provide a deeper scientific understanding of the nature of bacterial wilt resistance; and
- Apply the Advanced Backcross Quantitative Trait Loci (AB-QTL) method to discover, map, and backcross beneficial genes from two wild Lycopersicon species (*L. chilense* and *L. hirsutum*) improving adaptation to high temperatures (high temperature fruit set, high dry matter accumulation, lycopene development, and drought tolerance) and resistance to major tropical diseases and insects (geminiviruses, bacterial wilt, late blight, early blight, Cucumber mosaic virus, and tomato fruitworm).

The project will enhance the capacity of AVRDC and the National Agricultural Research System (NARS) to efficiently utilize crop genetic resources and molecular markers for genetic improvement, provide molecular markers linked to beneficial genes, and finally develop high yielding, multiple disease resistant tomato lines for tropical vegetable farmers. The project will enable AVRDC and its partners to move their tomato breeding programs into a very strategic direction by effectively using proven molecular markers to 1) intensify tapping of wild species to identify genes to improve tropical tomato and 2) pyramid resistance genes to achieve stable disease resistance. Integration of this new biotechnology into strong conventional breeding programs will result in higher yielding tomato cultivars for tropical farmers.

Tomato researchers worldwide will benefit from access to the novel genes and linked molecular markers discovered in the project. Elite tomato lines incorporated with novel genes will be developed and freely distributed to public and private sectors as an international public good. Ultimately vegetable farmers and consumers will benefit from superior tomato cultivars with durable resistance to diseases and insects, and tolerance to high temperatures resulting in reduced risk and price seasonality.

5. Development of locally adapted, multiple disease-resistant, high yielding chili (*Capsicum annuum*) cultivars for China, India, Indonesia and Thailand

Funded by
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)

Total budget
EUR 1,000,000 (USD 1,296,000)

Budget for AVRDC
EUR 637,100 (USD 720,800)

Project duration
April 2005 – March 2008

AVRDC staff involved
Sylvia Green (plant virologist), Paul Gniffke (pepper breeder), Chien-an Liu (Molecular Biologist), Robert de la Peña (Molecular Plant Breeder), Tien-chen Wang (plant mycologist), Jaw-fen Wang (plant bacteriologist), and Manuel Palada (crop and ecosystem management specialist)

Partner institutes
Hunan Plant Protection Institute, China; Indian Institute of Horticultural Research, India; Tropical Vegetable Research Center, Kasetsart University, Thailand; Bogor Agricultural University, Indonesia; and University of Hamburg, Germany

Executive Summary
This project seeks to raise income and reduce risk of resource-poor chili farmers of China, India, Indonesia, and Thailand by increasing the yield of preferred locally adapted chili varieties (PLVs). The project targets major diseases which are known to contribute to low yields in the tropics namely Cucumber mosaic virus (CMV), Chili veinal mottle virus (ChiVMV), bacterial wilt (BW) caused by *Ralstonia solanacearum*, anthracnose caused by several *Colletotrichum* species, Phytophthora blight caused by *Phytophthora capsici* and begomoviruses. It aims to:

- Isolate and characterize the local diversity of the targeted pathogens;
- Identify sources of resistance to the local pathogen strains;
- Develop efficient molecular diagnostics and screening methodologies;
- Develop or refine for use molecular markers for targeted diseases;
- Determine the mode of inheritance to each of the pathogens by classical methods complemented by molecular markers and disease diagnostics;
- Incorporate multiple disease resistance into the PLVs; and
- Develop locally acceptable and sustainable improved crop management practices in collaboration with the NARS.

Farmers and NARS extension agents will participate with breeders in selecting plants in the advanced segregating generations so that the final varieties meet local needs.

Chili pepper (*Capsicum annuum*) is a major crop for smallholders and resource-poor farmers in Asia, generating a significant income in local as well as export markets. Approximately 0.76 million ha are devoted to chili production in the targeted countries. According to country reports submitted in the initial project workshop, yields in these countries are unstable and low (about 5.5 t/ha compared to 10–17 t/ha elsewhere), largely due to viral, bacterial, and fungal diseases prevalent in the tropics and subtropics. Farmers frequently use large quantities of expensive and toxic pesticides to control these diseases, often with little success. Cultivars with multiple disease resistance are not available.

Benefits of this work will flow to poor vegetable farmers through reduced risk, increased yields and improved yield stability. Their incomes will be enhanced by increasing yields, improving the market quality of the fruit, and by reducing the amount of chemicals needed to produce a disease-free crop. Consumers will benefit from safer and better quality chili.

Researchers worldwide, especially in the tropics, will benefit from the improved understanding of regional variations in the targeted pathogens, from improved easy-to-use diagnostics, molecular markers, and from access to the newly identified disease resistance sources. Improved chili lines will be freely distributed to the public and private sectors as an international public good and serve as a platform for further varietal improvement.

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6 Asia & Pacific Seed Association core funding

Funded by
The Asia and Pacific Seed Association (APSA)

Total budget
USD 450,000

Budget for AVRDC
USD 450,000

Project duration
March 2006 – March 2009

AVRDC staff involved
Jackie Hughes (Deputy Director General for Research), Peter Hanson (tomato breeder), Paul Gniffke (bulb *Allium* and pepper breeder), Zhanyong Sun (cucurbit breeder), Robert de la Peña (Molecular Plant Breeder), Jaw-Fen Wang (plant bacteriologist), Srinivasan Ramasamy (entomologist), Tien-Chen Wang (plant mycologist), Ray-Yu Yang (nutrition specialist), Sylvia Green (plant virologist)

Partner institutes
24 APSA members contributing the core funds

Executive Summary
The Asia and Pacific Seed Association has had a long relationship with AVRDC–The World Vegetable Center. APSA's mission is to improve production and trade of quality seed and planting material of agricultural and horticultural crops in the region. It is a regional forum for formulating recommendations on seed policy issues, for stimulating technical and economic cooperation among seed enterprises in the region, and for the systematic interchange of information on various aspects of seed (breeding, production, conditioning, quality control, and marketing). AVRDC's mission in the Asia and Pacific region is to improve nutrition and reduce poverty in the tropics through vegetable research and development by building partnerships and mobilizing resources from private and public sectors to effectively tackle problems of vegetable production and consumption in the tropics. Both AVRDC and APSA are dedicated to improving the lives of the farming communities and building up the agricultural sector in Asia.

APSA channels funds from its members to AVRDC. These resources originate from a special membership group within APSA. The funding level envisaged for successful research activities along the themes identified in the May 2004 Workshop is about USD 0.25 million per year. To ensure continuity of research activities, AVRDC considers a 3-year timeframe as the minimum to ensure success of the arrangement. An annual workshop is envisaged as a means to up-date members' knowledge, to highlight new or emerging issues, and to re-prioritize research activities based on new knowledge. Research reports will be provided on identified key issues agreed between APSA and AVRDC

prior to becoming international public goods and an annual report can be provided to APSA on the output and research results on identified issues.

APSA and APSA members will have :

- Priority access to key AVRDC research results;
- Targeted research to address members' needs (within the mission and objectives of AVRDC);
- Their research concerns (appropriate within the Center's mission and vision) addressed;
- Access to training courses and possibility of tailor-made training activities, where appropriate;
- Reduced administration costs with respect to research management; and
- Public awareness possibilities for contribution to regional research activities.

7 Improving rural livelihoods through development of vegetable-based post-harvest technologies in Cambodia, Lao People's Democratic Republic, and Vietnam

Funded by
Asian Development Bank (ADB)

Total budget
USD 700,000

Budget for AVRDC
USD 522,000

Project duration
February 2005 – January 2008

AVRDC staff involved
Katinka Weinberger (socio-economist), Antonio Acedo (Regional Project Coordinator), Win-Win Kyi (Small-scale Enterprise Advisor), Manuel Palada (crop and ecosystem management specialist), Paul Gniffke (pepper breeder), Dolores Ledesma (biometrician), and Peter Hanson (tomato breeder)

Partner institutes
Department of Agronomy and Agricultural Land Improvement, Ministry of Agriculture, Forestry and Fisheries Phnom Penh, Cambodia; Department of Agriculture, Ministry of Agriculture and Forestry, Vientiane, Lao People's Democratic Republic; and Research Institute of Fruits and Vegetables, Ministry of Agriculture and Rural Development, Hanoi, Vietnam

Executive Summary
Vegetable production in Cambodia, Lao PDR, and Vietnam is characterized by high postharvest losses that reduce profits of farmers and marketers. Constraints to vegetable production include the lack of varieties suitable for processing and shipping, inadequate marketing information and skills, poor handling and storage technologies, and undeveloped processing industries. Cambodia has recently started to enhance the diversification and commercialization of its agricultural sector by improving its facilities for postharvest handling, storage, and processing, and by developing agricultural quality standards. Similarly, Vietnam plans to expand production of high-quality vegetables and to transfer small-scale processing equipment to small-scale farmers.

Improving pre-harvest processing technologies and promoting postharvest micro-enterprises will stimulate employment, enhance rural economic development, and stimulate economic growth and sustainability. Improving the postharvest vegetable sector will result in sustained year-round availability of vegetables and vegetable-based products. Promoting the postharvest food chain will encourage private sector participation in the Greater Mekong Subregion countries, which will further enhance the vegetable supply. This will also facilitate economic cooperation, improved marketing systems, and human capacity building.

Information exchange among GMS countries is very important. Collaborative training for food processing is already underway. Cross-border training in fruit and vegetable processing, however, is limited. Experience shows that after training, reliable supplies of high-quality food products become available and agroprocessors and exporters can significantly expand their share in regional/international markets for processed food products.

The Project's long-term goal is to reduce poverty, enhance rural economic development, and improve food security in Cambodia, Lao PDR, and Vietnam by promoting the vegetable postharvest sector. Specific purposes of the Project are to:

- Reduce postharvest losses of high volume, high value vegetable commodities; and
- Develop and promote low-cost, postharvest technologies in collaboration with both public and private sectors.

The expected outputs are:

- An in-depth assessment of the vegetable supply chain in Cambodia, Lao PDR, and Vietnam;

- High-yielding varieties of popular vegetables with improved shipping and processing qualities selected and made available;
- Training, capacity building, and information dissemination in postharvest handling and processing; and
- Strengthened partnerships among CLV countries.

8. Integrated disease management (IDM) for anthracnose, Phytophthora blight, and whitefly transmitted geminiviruses in chili pepper in Indonesia

Funded by
Australian Centre for International Agricultural Research (ACIAR)

Total budget
USD 704,800

Budget for AVRDC
USD 578,470

Project duration
April 2006 - April 2010

AVRDC staff involved
Paul Gniffke (pepper breeder), Madhusudan Bhattarai (Agricultural Economist), Manuel Palada (crop and ecosystem management specialist), Tien-chen Wang (plant mycologist), Sylvia Green (plant virologist), and Greg Luther (IPM/ Development Specialist)

Partner institutes
Commonwealth Scientific and Industrial Research Organisation-Entomology, Australia; New South Wales Department of Primary Industry, Australia; Indonesian Vegetable Research Institute, Indonesia; Assessment Institute for Agricultural Technology, Indonesia; and Bogor Agricultural University, Indonesia

Executive Summary
In Indonesia, chili pepper (*Capsicum* species) is an important cash crop, providing income and nutritional benefits to smallholder producers. However, disease losses seriously affect crop productivity and supply/price reliability. Phytophthora blight (PB) caused by *Phytophthora capsici*, and anthracnose, caused by *Colletotrichum* species, are the two most serious fungal problems, while whitefly-transmitted geminiviruses (WTG) are frequently implicated in crop failures. The development of satisfactory control measures against these diseases is a high priority for AVRDC-The World Vegetable Center and Indonesian R&D collaboration.

Commercial cultivars carrying resistance to the diseases have not yet been released, and some cultural practices favor disease development. Recommended fungicides for anthracnose and PB control are often ineffective, with excessive pesticide sprays (up to 100, averaging 40 sprays/season) applied to the crop. Yield losses in local and open pollinated (OP) varieties of 50% have been reported. Furthermore, white fly transmitted virus losses are compounded by inadequate control of vector and alternate hosts.

The project will capitalize on and complement progress made under previous AVRDC collaboration on chilli disease management in Indonesia. Likelihood of success will be enhanced through due attention to the socio-economic context impacting technology/variety development and adoption in farmer-centered approaches, as well as through the use of advanced approaches to pathogen characterization and efficient screening methodologies.

The overall purpose of this project is to identify and demonstrate effective integrated strategies to limit losses to Phytophthora blight, anthracnose, and whitefly-transmitted geminiviruses in chili peppers in Indonesia. The specific objectives of the project are:

- To assess and address the socioeconomic and horticultural practices affecting adoption of disease control options in Central Java;
- To characterize biological factors affecting disease incidence and severity of anthracnose, Phytophthora blight, and whitefly transmitted geminiviruses on chili;
- To assess integrated crop management strategies for sustainable control of anthracnose, Phytophthora blight, and whitefly transmitted geminiviruses;
- To continue development of locally acceptable varieties carrying effective resistance to anthracnose and Phytophthora blight, and search for lines resistant to whitefly transmitted geminiviruses.

Key outputs from the project will be recommendations for culturally appropriate improved low- and medium-input crop management approaches to disease control for chili pepper, and the identification and use of disease resistance in various breeding activities, to enable sustainable development of the smallholder vegetable industry.

9. Integrated crop management package for sustainable smallholder gardens in the Solomon Islands

Funded by
Australian Centre for International Agricultural Research (ACIAR)

Total budget
USD 571,045

Budget for AVRDC
USD 369,194

Project duration
May 2007 - April 2011

www.avrdc.org

AVRDC staff involved
Manuel Palada (crop and ecosystem management specialist), Katinka Weinberger (socio-economist), Liwayway Engle (Geneticist), Greg Luther (IPM/Development Specialist), Chih-hua Ma (soil scientist), Peter Hanson (tomato breeder), Paul Gniffke (pepper breeder), and Dolores Ledesma (biometrician)

Partner institutes
New South Wales Department of Primary Industry, Australia; Ministry of Agriculture and Livestock, Solomon Islands; Kastom Garden Association, Solomon Islands; Don Bosco Technical Institute and Rural Training Center, Solomon Islands; Vois Blong Mere Solomons, Solomon Islands; and Farmset Limited, Papua New Guinea

Executive Summary
The Solomon Islands (SI) is one of the poorest island nations in the Pacific with a per capita Gross National Income (GNI) of AUD 925. Subsistence agriculture and fishing comprise over 80% of the livelihoods of Solomon Islanders. Smallholder vegetable gardens in the SI are sources of food and income for rural and urban population, yet the area cultivated to vegetables is small compared to major staple starchy crops. However, there is a growing number of smallholder vegetable farms around the capital, Honiara, on Guadalcanal and the neighboring islands of Malaita and Makira. In spite of this encouraging trend, local production and supply are short to meet year-round domestic demands. There is great potential for improving and increasing vegetable production in the SI.

The aim of the project is to increase the economic status and potential income generation opportunities for Solomon Islanders by developing and promoting integrated and improved crop management packages for smallholder vegetable gardens. The project's specific objectives are:

- To assess targeted socio-economic dimensions of smallholder gardens, specifically, current crop production management practices and constraints and selected changes in these practices, the market potential for new vegetable species and varieties, and the potential market distortions from increased vegetable production and supply to formal SI markets;
- Evaluate selected 'new' vegetable varieties, including indigenous types, for adaptability, quality, and market potential and ensure seed availability of these varieties for supply to farmers at reasonable cost;
- Evaluate selected low-input crop management practices such as low-cost drip irrigation and starter fertilizer; and manage major insect pests and diseases using IPM technology for year-round smallholder vegetable production; and
- Build up and strengthen the capacity of local partners and collaborating institutions in carrying out research and extension activities for smallholder gardens.

The project will be based on the results of participatory and multidisciplinary rural appraisals. After identification of promising and adapted varieties with preferred acceptance by consumers, AVRDC will facilitate production and supply of seed to meet local demands. IPM practices on selected, improved vegetable varieties will be adapted. Low-input, improved crop management practices will be evaluated in year-round vegetable gardening for sustainable production. Selected improved varieties and improved crop management practices will be promoted and disseminated for nation-wide adoption and maximum impact. The improved gardening package will be disseminated through mass media, field days and demonstrations, farmer networks, SI's agriculture ministry, and NGOs.

7. THEMATIC IMPLEMENTATION OF PROJECTS ACROSS REGIONS

7.1 Theme 1: Germplasm conservation, evaluation and gene discovery

Coordinator: Liwayway Engle
Deputy: Robert de la Peña

Vision

To collect and conserve and distribute vegetable germplasm for present and future needs, and to evaluate the collection for desirable traits; characterizing them using molecular tools.

Mission

To assemble a large collection of vegetable germplasm that will answer the present need for germplasm in vegetable improvement programs and preserve germplasm for future needs, and to provide materials to diversify diets and production systems, improve nutrition and increase income of resource-poor households. This will be achieved through the collection of genetic materials that will support the needs of the current vegetable breeding programs, for example, sources of resistances to diseases and insects, tolerance to abiotic stresses, efficient nutrient use, long storage life, and enhanced nutritional quality and yield. The collection will also include a diverse array of vegetable germplasm indigenous to the regions where AVRDC has existing activities. The diversity will be analyzed to develop effective conservation and utilization strategies. Classical and molecular tools will be used to identify specific DNA segments associated with specific traits to develop genetic materials, characterize genomes, and introgress genes to facilitate development of superior vegetable varieties.

More specifically

- To collect, conserve and distribute vegetable genetic resources including wild relatives, genetic stocks and populations;
- To exploit vegetable genetic resources for increasing the levels and effectiveness of important horticultural traits and diversifying the genetic base of vegetable varieties;
- To enhance understanding and use of genetic diversity in the vegetable germplasm collection through the application of classical and molecular genetics, genomics and bioinformatics;
- To develop specialized genetic materials, molecular tools, and methods to enable development of new varieties more rapidly and effectively; and
- To use genomics and molecular technologies for isolation, validation, and functional analysis of genes affecting important horticultural traits.

What will be needed to implement this mission over the next three years?

- Collections of germplasm known to be sources of resistance to biotic and abiotic stresses or desirable horticultural and quality traits will need to be expanded to increase the possible sources of desired genes in our breeding programs;
- Expanded collection of indigenous vegetable accessions from the Mekong region of Southeast Asia will be needed to cover gaps in collecting in China; and
- Additional staff and equipment will be needed to be able to expand our molecular and gene characterization and identification for target traits that are available in our genebank;
- An integrated and effective trait screening and gene introgression program will be developed to accelerate development of superior vegetable lines and varieties;
- The activities and maintenance of the genebank are very much dependent on unstable funding sources from projects. More stable and assured sources of funds have to be made available to properly maintain this rich global resource;
- The aging facilities of the genebank need to be refurbished, for example, the seed processing and packing room where insulation leakage is becoming a serious problem;
- Acquisition of modern equipment such as an automated germination and quality testing machine will ensure that the seeds stored in the genebank are of good quality;
- To more effectively utilize the collection will require the development of new core collections for AVRDC priority crops and refining existing cores;
- Expanded capacity to effectively evaluate germplasm for abiotic stresses;
- Enhanced basic infrastructure for marker-assisted breeding and deoxyribonucleic acid (DNA) fingerprinting that includes marker development for priority crops, effective marker detection systems, and laboratory automation, and information technology (IT) systems; and
- Developing capacity and networks for genomics and molecular biology research such as cloning and transformation systems, and bioinformatics to support gene discovery, molecular breeding, and transgenic research.

The Theme Logframe

Theme 1 - Germplasm conservation, evaluation, and gene discovery

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

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

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

Narrative	Objectively Verifiable Indicators
Activity 1.1 Collect indigenous vegetable germplasm and legumes in China, South Asia and Southeast Asia regions	Output Targets 2008 • 500 accessions in (Sabah, Sarawak and Brunei) and Myanmar, Lao PDR, and South Asia region collected Output Targets 2009 • 500 accessions collected in China
Activity 1.2 Maintain effective regeneration of priority vegetable germplasm in AVRDC	Output Targets 2007 • 1,000 accessions at HQ; 200 accessions at RCA; 100 accessions in Mali regenerated Output Targets 2008 • 1,000 accessions at HQ; 200 accessions at RCA; 100 accessions in Mali regenerated Output Targets 2009 • 1,000 accessions at HQ; 200 accessions at RCA; 100 accessions in Mali regenerated
Activity 1.3 Distribute vegetable germplasm accessions and improved lines worldwide	Output Targets 2007 • 80% of vegetable germplasm requests served Output Targets 2008 • 80% of vegetable germplasm requests served Output Targets 2009 • 80% of vegetable germplasm requests served
Activity 1.4 Systematically file electronic databases information related to the conservation and distribution of vegetable germplasm maintained in AVRDC	Output Targets 2007 • 100% of data generated in 2006 put in the AVRDC Vegetable Genetic Resources Information System (AVGRIS), Regional offices get copies of AVGRIS templates Output Targets 2008 • 100% of data generated in 2007 put in AVGRIS; HQ and regional databases linked Output Targets 2009 • 100% of data generated in 2008 put in AVGRIS

Narrative	Objectively Verifiable Indicators
Activity 1.5 Develop strategies on in situ conservation of indigenous vegetables	Output Targets 2007 • Indigenous vegetable production integrated into agroforestry system in Philippines and Indonesia Output Targets 2008 • Participatory evaluation conducted in Philippines and Indonesia Output Targets 2009 • Results of activity published; production technologies, marketing, and policies supporting on-farm diversity of selected African and Asian indigenous vegetables developed
Activity 1.6 Develop effective seed health and quarantine program at AVRDC's HQ and the regional centers	Output Targets 2007 • Seed introduced to AVRDC including the regional centers and AVRDC germplasm shipped abroad is free of pathogens and insects • Genebank procedures that will ensure that the collection maintained at GRSU is free of genetically modified organism (GMO) Output Targets 2008 • A database on globally important quarantine pests compiled and liaison with the Bureau of Animal and Plant Health Inspection and Quarantine (BAPHIQ) and local institutes established to determine their presence in Taiwan • Accurate detection methods for quarantine pests, seed borne pathogens and pests, and methodologies for their effective elimination developed for AVRDC priority crops Output Targets 2009 • Quarantine techniques for melon fly in bitter gourd developed

Output 2: Trait-based characterization and screening of vegetable germplasm conducted to increase the levels and effectiveness of important horticultural traits and to diversify the genetic base of vegetable varieties

Narrative	Objectively Verifiable Indicators
Activity 2.1 Identify and characterize sources of resistance to diseases in *Capsicum* pepper	Output Targets 2007 • Chili pepper accessions screened for resistance to anthracnose, Phytophthora blight, Chili veinal mottle virus, and whitefly transmitted geminivirus Output Targets 2008 • Resistance to anthracnose, PB, chiVMV, and WTG identified Output Targets 2009 • Chili pepper accessions characterized for resistance to anthracnose, PB, ChiVMV, and WTG

Narrative	Objectively Verifiable Indicators
Activity 2.2 Identify and characterize sources of resistance to insect pests and diseases in tomato	Output Targets 2008 • Accessions of tomato screened for resistance to thrips, white-fly, fruitworm, bacterial wilt, tospoviruses, and geminiviruses Output Targets 2009 • New sources of resistance to Phytophthora leaf blight in tomato identified • Accessions of African indigenous solanaceous crops screened for resistance to thrips and spider mites
Activity 2.3 Identify and characterize sources of resistance to diseases in cucurbits	Output Targets 2007 • Sources of resistance to five major viruses of cucurbits in the Genetic Resources and Seed Unit (GRSU) cucurbit collection identified and assembly of germplasm with "reported" virus resistance assisted Output Targets 2008 • Sources of resistance to 5 major viruses of cucurbits in the GRSU cucurbit collection characterized and assembly of germplasm with "reported" virus resistance assisted Output Targets 2009 • Cucurbits screened for resistance to downy mildew and powdery mildew
Activity 2.4 Identify and characterize sources of resistance to drought and heat stress in solanaceous crop species and African indigenous vegetables (cucurbits)	Output Targets 2008 • Accessions of solanaceous species and AIVs (cucurbits) screened for drought and heat tolerance. Protocols for screening resistance to drought and heat developed Output Targets 2009 • Tolerant accessions of solanaceous crop species and AIVs (cucurbits) identified
Activity 2.5 Conduct proximate analysis of tomato and *Capsicum* pepper for selected nutrition-related compounds	Output Targets 2007 • Lycopene, beta-carotene, sugar, fiber, and vitamin C levels in accessions of tomato determined Output Targets 2008 • Capsaicin, sugar, fiber, vitamin C levels in accessions of *Capsicum* pepper determined
Activity 2.6 Select promising accessions of neglected indigenous vegetables and varieties for promotion	Output Targets 2007 • Superior genotypes promoted in Eastern and Southern Africa, Southeast Asia, and the CAC region

Output 3: Characterized germplasm to enhance understanding and use of biodiversity in the vegetable germplasm collection

Narrative	Objectively Verifiable Indicators
Activity 3.1 Characterize morphological traits of vegetable germplasm maintained at AVRDC and RCA	Output Targets 2007 • 1000 accessions characterized at HQ and 200 accessions at RCA based on standard morphological descriptors Output Targets 2008 • 1000 accessions characterized at HQ and 200 accessions at RCA based on standard morphological descriptors Output Targets 2009 • 1000 accessions characterized at HQ and 200 accessions at RCA based on standard morphological descriptors
Activity 3.2 Conduct molecular characterization, genetic relationship, and diversity analysis of germplasm	Output Targets 2007 • Molecular characterization of C genome of common cabbage, broccoli, cauliflower, and Chinese kale • Molecular genetic of leafy brassicas (pakchoi, choysum, kailaan) analyzed Output Targets 2008 • Species-specific markers for C genome brassicas developed Output Targets 2009 • Cross-compatibility of *B. oleraceae* species determined
Activity 3.3 Develop, characterize, and validate AVRDC germplasm core collection	Output Targets 2007 • Core collections for major crop groups, wild species, indigenous vegetables with large number of accessions developed, characterized, and validated using morphological and molecular data Output Targets 2008 • Core collections for major crop groups, wild species, indigenous vegetables with large number of accessions developed, characterized, and validated using morphological and molecular data Output Targets 2009 • Core collections for major crop groups, wild species, indigenous vegetables with large number of accessions developed, characterized, and validated using morphological and molecular data

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

Narrative	Objectively Verifiable Indicators
Activity 4.1 Develop mapping populations and identify quantitative trait locis (QTLs) for biotic and abiotic stresses and improved nutritional levels	Output Targets 2008 • Mapping populations developed/identified and screened for drought and/or heat tolerance, and resistance to tomato yellow leaf curl virus (TYLCV) and bacterial wilt Output Targets 2009 • Identification, introgression, and mapping of genes for heat and/or drought tolerance, and resistance to TYLCV and BW in tomato; heat tolerance in pepper; lycopene, B-carotene, capsanthin in tomato and pepper
Activity 4.2 Conduct fine mapping of QTLs and develop markers for Marker Assisted Selection (MAS)	Output Targets 2007 • Ty-2 markers developed for MAS Output Targets 2008 • Ty-1, Ty-3, bruchid, and anthracnose markers developed for MAS Output Targets 2009 • QTLs for BW resistance in tomato mapped and DNA markers developed; early blight resistance in LA1777 fine mapped
Activity 4.3 Assemble and develop molecular marker sets for AVRDC priority crops	Output Targets 2007 • 500 SSR marker set for pepper assembled Output Targets 2008 • 1000 SSR marker set for tomato developed

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

Narrative	Objectively Verifiable Indicators
Activity 5.1 Determine allelic variation in carotenoid biosynthetic genes associated with increased carotenoid levels	Output Targets 2009 • Allelic variants of carotenoid biosynthetic genes that increase levels of carotenoids in pepper and tomato identified
Activity 5.2 Characterize and validate candidate genes for heat and drought tolerance	Output Targets 2009 • Critical candidate genes for heat and drought tolerance validated and prioritized
Activity 5.3 Characterize bacterial wilt resistance genes in tomato	Output Targets 2009 • Efficacy of candidate BW genes determined; role of plant defense genes in resistance to BW in solanaceous crops elucidated
Activity 5.4 Develop protocol for pepper transformation	Output Targets 2007 • Transformation using GUS gene in Korean hybrid varieties demonstrated

Output 6: IPR strategy on germplasm, transgenics, and genes implemented

Narrative	Objectively Verifiable Indicators
Activity 6.1 Collaborate with IPR personnel in the development of IPR strategy for AVRDC	Output Targets 2008 • Material Transfer Agreement (MTA) for genes and constructs reviewed and upgraded Output Targets 2009 • New MTA and germplasm acquisition agreement compatible with international treaties and agreements developed

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

Narrative	Objectively Verifiable Indicators
Activity 7.1 Train human resources in vegetable genetic resources conservation, management, and evaluation using conventional and advanced techniques	Output Targets 2007 • Three Korean staff trained in regeneration and characterization of germplasm; 4 Filipino staff trained in conservation and promotion of indigenous vegetables; Training on use of molecular tools for biodiversity analysis and germplasm evaluation conducted Output Targets 2008 • Three Korean staff trained in regeneration and characterization of germplasm; 10 Filipinos trained in conservation and promotion of indigenous vegetables; Training on use of molecular tools for biodiversity analysis and germplasm evaluation conducted Output Targets 2009 • Training on evaluation for resistances to biotic and abiotic stresses conducted; Training on use of molecular tools for biodiversity analysis and germplasm evaluation conducted

7.2 Theme 2: Genetic Enhancement and Varietal Development of Vegetables

Coordinator: Peter Hanson
Deputy: Paul Gniffke

Vision
To produce varieties which break the boundaries of tropical vegetable production.

Mission
To produce tropically-adapted varieties and lines of major vegetables that consistently produce high yields of nutritious and marketable food with less risk and environmental damage. This will be achieved through improved heat and stress tolerance, multiple disease and insect resistance, high content of micronutrients and bioactive compounds and good appearance. These will be designed for use by low income farmers, developed in partnership with those who work closely with them, in environments with major needs and with primary reliance on conventional breeding techniques.

More specifically
- To provide low income farmers with cost-effective means of boosting the crop productivity of tomato, chili, sweet pepper, alliums, vegetable soybean, mungbean, cucurbits, and crucifers;
- To produce both finished varieties and bred lines that are tropically adapted, consistently producing high yields of nutritious, quality vegetables with less risk and environmental damage and improved marketability;
- To focus on heat and stress tolerance, multiple disease and insect resistance, high content of micronutrients and bioactive compounds, and good appearance;
- To work in close partnership with NARES, NGOs, universities, and private seed companies;
- To rely primarily on conventional plant breeding with increasing use of molecular marker technologies, and interspecific crosses to broaden the genetic base of vegetable crops;
- To employ transgenic strategies only where major problems stymie conventional breeding; and
- To expand vegetable breeding programs beyond Headquarters to Central America and Africa.

What will be needed to implement this mission over the next three years?
- Transfer of most bulb *Allium* breeding and seed production from Headquarters to Tanzania. Shallot and garlic development might better be conducted in Thailand where these crops are important;
- Strengthen crucifer breeding by hiring a fulltime breeder;
- Establish facilities and hire staff at Regional Centers and Offices to enable multilocation testing of AVRDC bred germplasm;
- Effective coordination of breeding activities among Headquarters, Regional Centers, and NBUs;
- Improve capacity for large scale seed production of selected AVRDC lines and hybrids for development-oriented projects;
- Investigate opportunities for breeding tropical vegetable legumes such as hyacinth bean (*Dolichos* species), yardlong bean (*Vigna* species), winged bean (*Tetragonolobos* species), among others, including staffing and station issues.
- Establish breeder or crop physiologist in Mali station (Bamako) and/or RCSA (Hyderabad) to establish protocols for germplasm evaluation and breeding for drought tolerance in selected vegetables and wild relatives;
- Establish an African eggplant breeding program in Mali or RCA-Tanzania; and
- Central America station needs to:
  - Identify and implement partnership with host institution; and
  - Hire staff and set up an AVRDC office.

The Theme Logframe

Theme 2: Genetic enhancement and varietal development of vegetables

Goal: Varieties with potential to expand opportunities in tropical vegetable production, developed and utilized.

Purpose: Varieties and lines of major vegetables, that produce high yields of nutritious and marketable food with less health risk and environmental damage, available to poor farmers.

Output 1: Varieties and lines of vegetable with improved disease resistance, higher stress tolerance, and better nutritional content

Narrative	Objectively Verifiable Indicators
Activity 1.1 Develop disease-resistant and/or high carotenoid (beta-carotene and lycopene) tomato	Output target 2007 • 10-20 begomovirus resistant F7 lines and hybrids increased, distributed, and tested at multilocations Output target 2008 • 5-10 late blight resistant F7 Ph-3 + Ph-2 lines distributed internationally and 2-3 Ph-3 RCA lines distributed in Africa • Molecular markers for Ty-1, Ty-2, Ty-3 genes for begomovirus resistance applied in MAS and line characterization • 10-20 begomovirus resistant F7 lines and hybrids increased, distributed, and tested at multilocations Output target 2009 • 10-20 F7 begomovirus resistant lines and hybrids increased, distributed, and tested at multilocations • 5 indeterminate begomovirus resistant- F7 tomato lines identified and distributed • Lines selected to improve the ICRIXINA tomato population-West Africa • 5-10 F7 lines with high lycopene or beta-carotene content distributed internationally • Opportunities for home garden use/niche markets explored for high beta-carotene tomato and NGO linkages established
Activity 1.2 Develop and distribute disease-resistant chili and sweet pepper varieties (targeting anthracnose, Phytophthora blight, bacterial wilt, Cucumber mosaic virus, Chili veinal mottle virus, and/or begomovirus)	Output target 2007 • Inheritance of resistance to anthracnose, PB, CMV, ChiVMV, and BW studied • 1-4 advanced lines carrying resistance to two or more diseases developed • Methodology developed to sequentially screen for CMV (and/or ChiVMV), BW, and anthracnose • Initial crosses for begomovirus resistance made • Seed of 10 to 15 new lines distributed through International Chili Pepper Nursery (ICPN) and International Sweet Pepper Nursery (ISPN) programs to 50 collaborators Output target 2008 • 1-4 advanced lines carrying resistance to two or more diseases developed • Inheritance study of begomovirus resistance conducted with cooperators • *Capsicum frutescens* germplasm for field resistance to begomovirus in Indonesia and Thailand evaluated in multilocation trials • Seeds of 10-15 new lines distributed through International Chili Pepper Nursery (ICPN) and International Sweet Pepper Nursery (ISPN) programs to 50 collaborators • Seeds provided to support cropping system trials in Aceh, Solomon Islands, and Cambodia • Lines distributed to NBU cooperators Output target 2009 • 1-4 advanced lines carrying resistance to two or more diseases developed • Seeds of 10-15 new lines distributed through International Chili Pepper Nursery (ICPN) and International Sweet Pepper Nursery (ISPN) programs to 50 collaborators
Activity 1.3 Develop heat tolerant tropical sweet pepper	Output target 2007 • Squash fruit habit evaluated for heat tolerance-variety trials • Heat tolerant x elite crosses and hot x sweet crosses made (crossing blocks) Output target 2008 • Parents and progenies evaluated in hot-humid locations (e.g. Cameroon) Output target 2009 • Test hybrid combinations evaluated • Seed of superior selections multiplied

Narrative	Objectively Verifiable Indicators
Activity 1.4 Refine hybrid variety technologies: Cytoplasmic male sterility (CMS) in chili and sweet pepper	Output target 2007 • Low-temperature stable CMS chili maintainer and restorer lines identified Output target 2008 • Low temperature stable CMS sweet pepper maintainer lines identified • Heterosis and combining ability in selected chili pepper backgrounds characterized at AVRDC Output target 2009 • CMS versions of additional elite lines developed • Heterosis and combining ability in selected chili pepper backgrounds characterized at AVRDC • Inheritance of low temperature stable CMS characterized
Activity 1.5 Develop short-day red onions and yellow onions for improved yield, extended shelf-life, and/or *Stemphyllium* resistance	Output target 2007 • Regenerated double haploid (DH) onion plants evaluated for ploidy, bulbing habit, *Stemphyllium* disease resistance, and seed fertility • Onions with superior ambient storage capacity identified • Superior AVRDC onion entries inventoried and prioritized for seed increase in Arusha • Strategy for improvement of West African onion populations designed Output target 2008 • Selected lines intercrossed and test crossed with elite parents for *Stemphyllium* resistance • Regional onion breeding programs established at RCA-Arusha and/or Mali Output target 2009 • Selected open pollinated onion lines provided to National Breeding Units and evaluated • Hybrids and recombined progenies evaluated for bulbing, *Stemphyllium resistance*, and seed productivity • Seed multiplied at RCA-Arusha and/or Mali for international trialing • Selected OP lines provided to NBU's and evaluated
Activity 1.6 Develop improved propagation methods for garlic	Output target 2008 • Plantima system evaluated • Garlic suspension culture technology refined; virus eradication effect confirmed

Narrative	Objectively Verifiable Indicators
Activity 1.7 Develop higher nutritional content leafy crucifer (pakchoy and choysum) and heat tolerant broccoli	Output target 2007 • Diversity among leafy crucifer varieties for carotenoids, glucosinolates, iron determined and published • Mass selection within superior commercial leafy crucifer varieties carried out Output target 2008 • Seed of leafy crucifer selections multiplied for international distribution Output target 2009 • Heat tolerant broccoli hybrids tested in multilocation trials
Activity 1.8 Develop improved vegetable soybean and mungbean with improved nutrition and flavor qualities	Output target 2007 • High sugar soybean lines evaluated and advanced • Isoflavone soybean breeding stopped and breeding materials kept as germplasm Output target 2008 • Presence of high methionine trait confirmed in mungbean backcross populations • Seed of basmati vegetable soybean lines increased Output target 2009 • Seed of basmati vegetable soybean lines distributed • Elite BC3F6 high methionine mungbean lines evaluated for agronomic traits
Activity 1.9 Develop cucumbers for improved disease-resistance, high beta-carotene, and/or gynoecious flowering	Output target 2007 • Germplasm collected and evaluated for disease resistance and horticultural traits • Disease screening protocols developed • Crosses made and generation advanced to improve disease resistance and/or other traits Output target 2008 • Selection generation advanced Output target 2009 • Cucumber lines tested in multilocation trials • Pickling type hybrids designed

Narrative	Objectively Verifiable Indicators
Activity 1.10 Develop disease resistant and high quality summer and winter squash	Output target 2007 • Germplasm of summer and winter squash collected, selected, and increased • Powdery mildew and virus screening protocols for winter squash developed • Inbred summer squash lines selected and advanced Output target 2008 • Summer squash hybrids designed and tested in multilocation trials Output target 2009 • Winter squash crosses and populations developed • Summer squash hybrids designed and tested in multilocation trials
Activity 1.11 Okra breeding for West Africa	Output target 2007 • Germplasm collected and evaluated Output target 2008 • Inbred lines selected and advanced

Output 2: Transgenically created vegetable varieties

Narrative	Objectively Verifiable Indicators
Activity 2.1 Biosafety evaluation of transgenic Cucumber mosaic virus-resistant tomato	Output target 2007 • Analysis of transgenic tomato for food safety produced Output target 2008 • Biosafety of transgenic tomatoes analyzed
Activity 2.2 Develop transgenic begomovirus-resistant tomato	Output target 2007 • Five constructs for transformation developed • 20 transgenic events developed Output target 2008 • 20 transgenic lines evaluated for resistance to begomovirus Output target 2009 • Five lines advanced based on acceptable molecular profile and efficacy
Activity 2.3 Develop transgenic Bt pest-resistant cabbage	Output target 2007 • Events expressing Bt protein in cabbage developed through collaboration with Nunhems • Advanced events with acceptable molecular profile and effective against diamondback moth (DBM) Output target 2008 • Efficacy of Bt proteins to target and non-target organisms determined • Outcrossing studies on *Brassica oleracea* initiated Output target 2009 • Regulatory documents filed to Indian GMO regulatory organization

Narrative	Objectively Verifiable Indicators
Activity 2.4 Develop legal framework to transfer the ownership of pest-resistant transgenic vegetable	Output target 2007 • Commercialization agreement developed between the partners to guide the transfer of ownership of two elite events from private partner to AVRDC • Stewardship document developed between the partners for Bt transgenic cabbage and cauliflower

Output 3: Improved capacity of players in vegetable breeding

Narrative	Objectively Verifiable Indicators
Activity 3.1 Conduct plant breeding training for National Breeding Units	Output target 2008 • 3-week "Breeding and Variety Selection of Vegetable Crops" course offered to Tanzania NBU Output target 2009 • 3-week "Breeding and Variety Selection of Vegetable Crops" course offered to Madagascar NBU
Activity 3.2 Conduct APSA workshops	Output target 2007 • Presentations, field plantings, and seed distribution Output target 2008 • Presentations, field plantings, and seed distribution Output target 2009 • Presentations, field plantings, and seed distribution
Activity 3.3 Conduct chili anthracnose symposium	Output target 2007 • 'First International Symposium on Chili Anthracnose,' 17-19 September 2007, Seoul, Korea organized and conducted

7.3 Theme 3: Seed and safe vegetable production systems

Coordinator: Jaw-fen Wang
Deputy: Greg Luther

Vision
To improve seed supplies of superior vegetable varieties for poor farmers and to provide research and outreach leadership to help them produce vegetables safely.

Mission
In partnership with NARES, to catalyze the expansion of seed supplies of superior vegetable varieties by supporting the development of local seed system. A range of integrated low-input or cost-effective organic vegetable production packages will be developed for resource-poor farmers to produce priority crops in key tropical locations. Extension and evaluation activities will be developed to assist partners to expand seed production and safe vegetable production.

More specifically
- In conjunction with African NARES, to catalyze the expanded involvement of local seed companies in the production and supply of superior vegetable varieties, particularly those bred or selected by the Center;
- To evaluate the vegetable seed sector in Central Asia and make recommendations for its improvement;
- To research and develop integrated production packages for priority vegetables that combine appropriate crops and varieties, biological control of insect pests, and low input fertilizer and drip irrigation systems suitable for resource poor farmers in the tropics;
- Because of the importance of organic crop production as a safe production system, appropriate crops and varieties and integrated crop management (ICM) packages will be selected to make organic crop production in the tropics both practical and economically sound; and
- To develop and contribute to implementing extension activities to expand seed production and the adoption of successful technologies beyond project sites. These will include raising awareness through the media and extension publications, knowledge building through field days, and skill building through training programs for extensionists, private seed sector, and farmers.

What will be needed to implement this mission over the next three years?
For the seed production part:

- Recruit seed production specialists, who are familiar with seed production technology, seed quality regulation, and seed trading.

For the research of IPM and ICM:

- AVRDC needs to continue to develop its own technologies and generate useful information which can be applied by resource-poor farmers. We need to identify clear research targets on topics where we can play a unique role;
- For each of our principal crops (tomato, chili pepper, sweet pepper, among others), principles of forming IPM and ICM packages should be developed for specific agroecological conditions to minimize use of pesticide/fertilizer/water, and achieve high yields; and
- The need to hire additional staff with various specialties (such as plant physiology, population genetics, and molecular ecology, among others) will be identified.

For the development and dissemination of IPM and ICM

- Vegetables are produced in diverse agro-ecosystems (environment, culture, market, among others). The aim should be to build capacity of local researchers/extension specialists/farmers to conduct needed experiments, form efficient/effective extension strategies, and optimize decision-making processes;
- Strategic locations and agricultural systems for IPM/ICM technology dissemination with agreeable criteria will be identified;
- AVRDC should develop its own multifaceted dissemination strategy, which can be adapted by NARES and NGOs. Its aspects and how to achieve it will be discussed in the Theme meeting;
- Database specialists should be recruited to develop various databases that can be used in decision-making processes. For example, databases on non-chemical pest control methods can be developed to compile available technologies for NARES and NGOs to choose from. Databases to store information of local vegetable production systems and effective production technology can be developed to document each of our dissemination projects. These specialists can also draw important information from grey literature and make it readily applicable by practitioners. Such accumulated information can possibly be used to develop expert systems to select the best-bet components to improve vegetable production in a range of agricultural systems and locations.

Overall
Effective coordination of breeding activities among Headquarters and Regional Centers/Offices is needed to assure an effective and fluid research and development.

The Theme Logframe

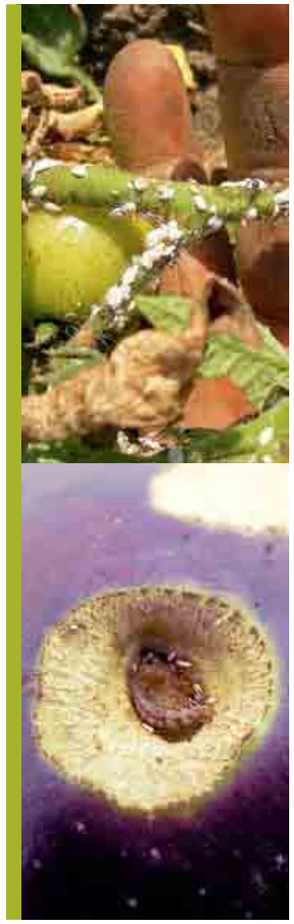
Theme 3: Seed and Safe Vegetable Production Systems

Goal: Substantial contributions to seed and safe vegetable production generated.

Purpose: Increased supply of quality seeds and safe vegetables through adoption of profitable, environmentally sound practices by farmers leading to knowledge-based farming.

Output 1: Integrated pest management technology developed/validated

Narrative	Objectively Verifiable Indicators
Activity 1.1 Diagnose and characterize pathogens of *Brassica* diseases	Output Targets 2008 • Powdery mildew and white rust pathogens on Ethiopian mustard in Tanzania characterized • At least three strains of turnip mosaic virus (TuMV) in Tanzania identified Output Targets 2009 • Diversity of black rot pathogen in Tanzania documented
Activity 1.2 Develop *Brassica* pest management technology	Output Targets 2007 • At least one heat tolerant pupal parasitoid of DBM identified • Efficiency of neem kernel extracts on managing DBM confirmed in Tanzania • Toxicity of pure *Bacillus thuringiensis* (Bt) toxins and freeze dried Bt transgenic tissues against *Brassica* insect pests confirmed • At least two trap crops for striped flea beetles identified • Quantity of allyl isothiocyanate in lures optimized for trapping striped flea beetles Output Targets 2008 • Effect of pure Bt toxins and freeze dried Bt transgenic tissues against four parasitoids and two predator of DBM determined • Pesticide delivery methods of *Brassica* seeds against *Brassica* pests in greenhouse developed Output Targets 2009 • Pesticide delivery methods of *Brassica* seeds against *Brassica* pests in greenhouse validated in the field • Development of an IPM package for powdery mildew and white rust of *Brassica* crop initiated
Activity 1.3 Characterize and develop cucurbit pests management	Output Targets 2007 • Cucurbit leafcurl geminivirus isolated and characterized in Taiwan Output Targets 2008 • At least five cucurbit leaf curl geminiviruses from Asia molecularly characterized • Pumpkin powdery mildew pathogen characterized Output Targets 2009 • Pumpkin powdery mildew management package developed



Narrative	Objectively Verifiable Indicators
Activity 1.4 Diagnose and characterize pest of solanaceous crops	Output Targets 2007 General • Diagnostic DNA markers for species identification of thrips in Taiwan developed • Phylotypic origin and virulence of bacterial wilt pathogen in Taiwan characterized Tomato • Two races of fusarium wilt of tomato in Taiwan molecularly characterized • Emerging new tomato geminivirus species identified in East and Southeast Asia • Candidate genes related to virulence of tomato bacterial wilt pathogen identified Pepper • Three pathotypes of Phytophthora blight of pepper in Taiwan molecularly characterized • Species of *Colletotrichum* causing pepper anthracnose in China, India, Indonesia, and Thailand identified • Molecular diversity of pepper ChiVMV in China, India, Indonesia, Taiwan, and Thailand determined Output Targets 2008 General • Diagnostic DNA markers for species identification of thrips in South- and Southeast Asia developed • Thrips population in South- and Southeast Asia characterized using DNA markers • Phylotypic origin of bacterial wilt pathogen in India and other Asian countries characterized Tomato • Molecular markers for profiling virulence of tomato bacterial wilt pathogen developed Pepper • Five pepper leaf curl virus species in China, India, Indonesia, Taiwan, Thailand, and other countries molecularly characterized Indigenous Vegetable • Verticillium wilt isolates collection from nightshade, African eggplant, and tomato established and characterized in Tanzania Output Targets 2009 General • Species of spider mites on solanaceous vegetables in Tanzania determined Tomato • Usefulness of molecular markers for profiling virulence of tomato bacterial wilt pathogen verified Indigenous Vegetable • Pathogenicity of *Verticillium* isolates on nightshade, African eggplant, and tomato population determined

Narrative	Objectively Verifiable Indicators
Activity 1.5 Develop and validate solanaceous crop pest management technology	Output Targets 2007 Tomato • IPM technology against whitefly, fruitworm, and common armyworm on tomato using resistant varieties, Bt, neem, and sex pheromones validated in Taiwan • Efficacy of neem and imidacloprid against whitefly on tomato, in greenhouse condition, confirmed • Efficacy of using Indian mustard to control tomato bacterial wilt, on-farm condition, evaluated Pepper • Efficacy of neem and imidacloprid against aphid on hot pepper in greenhouse confirmed • Suitable rootstock for managing soil-borne diseases of sweet pepper identified Output Targets 2008 General • Geographic information system (GIS) study on agroecology of *Helicoverpa armigera* in Uganda conducted Tomato • Repellency effect of spider plants against tomato pests determined • Effect of trap crops for thrips on chili peppers determined • Trials testing effectiveness of barrier crops on reducing whitefly/whitefly transmitted geminiviruses on tomato in Taiwan and Indonesia conducted • Integrated management package of tomato bacterial wilt for intensive production system at mid-elevation developed and tested on farm • Integrated management of tomato fusarium wilt developed Output Targets 2009 General • Agroecology of *Helicoverpa armigera* in Uganda determined through GIS study Tomato • The most effective barrier crop on reducing whitefly/whitefly transmitted geminiviruses on tomato in Taiwan and Indonesia identified • Integrated management of pepper Phytophthora blight and anthracnose developed • Development of an IPM package for Verticillium wilt of solanaceous crop initiated

Narrative	Objectively Verifiable Indicators
Activity 1.6 Diagnose and characterize pests of leguminous crops	Output Targets 2007 • Asian soybean rust pathogen molecularly in Taiwan characterized Output Targets 2008 • Asian soybean rust pathogen collected from South America and USA molecularly characterized • Lablab bean anthracnose isolates characterized in Tanzania Output Targets 2009 • Variation in legume pod borer population structure in South and Southeast Asia characterized
Activity 1.7 Develop IPM technology for leguminous crops	Output Targets 2007 • Mass-culturing techniques for a parasitoid (*Apanteles taragamae*) to legume pod borer (LPB) developed and standardized • Nature and extent of the parasitism by *A. taragamae* on LPB larvae evaluated • Mating disruption and mass trapping potential of the LPB sex pheromones determined • Efficacy of *Maruca vitrata* nuclear polyhedrosis virus (MvNPV) alone and in combination with Bt and neem to control LPB determined • IPM against LPB on yardlong bean and lablab bean validated in Taiwan • Efficacy of fungicides with low mammalian toxicity for soybean rust control confirmed Output Targets 2008 • IPM against LPB on cowpea and lablab bean validated in West Africa • At least one cultivar resistant/tolerant to Asian soybean rust in Taiwan identified • Population dynamics of aphids and their natural enemies on yardlong bean in agroforestry systems conducted Output Targets 2009 • IPM against LPB on yardlong bean and/or lablab bean validated in South and Southeast Asia • Population dynamics of aphids and their natural enemies on yardlong bean in agroforestry systems determined • Development of an IPM package for lablab anthracnose initiated
Activity 1.8 Characterize and manage okra pests	Output Targets 2008 • Control efficacy of neem cake on root-knot nematode on okra determined • Survey for viruses of okra in Asia and Africa initiated Output Targets 2009 • IPM packages for *Alternaria* leaf spot and powdery mildew on okra developed in Tanzania

Output 2: Integrated crop and soil management (ICSM) technology developed/validated

Narrative	Objectively Verifiable Indicators
Activity 2.1 Develop integrated crop management packages for various cropping systems	Output Targets 2007 • Evaluation of tomato, chili, and sweet pepper varieties under various cropping systems conducted in Taiwan and initiated at three locations in Philippines, Indonesia, and Thailand • Evaluation on ten species of IV conducted at three locations in the Philippines and Indonesia • ICM package for various cropping systems in Philippines, Indonesia, and Solomon Islands designed for tomato, chili, and sweet peppers Output Targets 2008 • Evaluation of tomato, chili, and sweet pepper varieties under various cropping systems conducted in Taiwan, Philippines, Indonesia, Thailand, and Solomon Islands • Evaluation of ten species of IV conducted at three locations in Philippines, Indonesia, and Solomon Islands • ICM package for various cropping systems in Philippines, Indonesia, and Solomon Islands validated for tomato, chili, and sweet pepper Output Targets 2009 • Superior varieties of tomato, chili, and sweet pepper suitable for various cropping systems in Taiwan, Philippines, Indonesia, and Solomon Islands identified and recommended • Superior varieties of IV suitable for various cropping systems in Philippines, Indonesia, and Solomon Islands identified and recommended • ICM package for various cropping systems in Philippines, Indonesia, and Solomon Islands recommended for tomato, chili, and sweet pepper
Activity 2.2 Develop improved water efficiency and productivity	Output Targets 2007 • Measurement methods on water requirement of vegetables identified • Minimum water requirement data collected for tomato, chili pepper, and leafy vegetables Output Targets 2008 • Simple and low-cost drip irrigation technology validated for various soil types during the dry season in Cambodia, Indonesia, Solomon Islands, Philippines, and Vietnam. • Low-cost drip irrigation integrated with other cultural practices such as mulching and grafting Output Targets 2009 • Low-cost drip irrigation technology for dry season vegetable production recommended

Narrative	Objectively Verifiable Indicators
Activity 2.3 Develop method to improve fertilizer efficiency and resource utilization	Output Targets 2007 • Balanced fertilization technology (BFT) designed and tested for tomato, chili pepper, cabbage and vegetable soybean • Effects of starter solution technology (SST) validated for chili pepper in Indonesia, India, and Thailand • Composting protocol developed • Protocol of fertilizer recommendations for vegetables using in situ quick test established Output Targets 2008 • BFT developed for tomato, chili pepper, cabbage, and vegetable soybean • Effects of SST validated for chili, tomato, sweet pepper, and amaranth in Solomon Islands, Indonesia, and Thailand • Composting protocol using locally available raw materials validated in Indonesia and Solomon Islands • Protocol of fertilizer recommendations for vegetables using in situ quick test validated • Training workshop on integrated soil fertility management (ISFM) concepts and technology conducted Output Targets 2009 • BFT adapted for chili, tomato, sweet pepper, cucumber, and amaranth in Solomon Islands, Indonesia, and Thailand • SST adapted for chili, tomato, sweet pepper, and amaranth in Solomon Islands, Indonesia, and Thailand • Protocol of fertilizer recommendations for vegetables using in situ quick test recommended • Soil management practices for rhizosphere health developed
Activity 2.4 Develop integrated soil fertility management package on problem soils	Output Targets 2007 • Protocol of ISFM package addressing sodicity, salinity, acid soils, or sandy soils in Indonesian tsunami-affected areas initiated Output Targets 2008 • Protocol of ISFM package addressing sodicity, salinity, acid soils, or sandy soils in Indonesian tsunami-affected areas validated Output Targets 2009 • Protocol of ISFM package addressing sodicity, salinity, acid soils, or sandy soils in Indonesian tsunami-affected areas recommended

Output 3: Organic production technologies developed/validated

Narrative	Objectively Verifiable Indicators
Activity 3.1 Evaluation of vegetable species and varieties suitable for organic farming systems	Output Targets 2007 • Preliminary trials to evaluate at least ten vegetable species conducted at AVRDC organic farm • Two to 12 varieties each of cabbage, cucumber, sweet pepper, vegetable soybean, and tomato evaluated at AVRDC organic farm • Seeds to screen African eggplant and sweet pepper varieties for resistance to soil-borne diseases (*Verticillium dahliae* and *Phytophthora capsici*) collected Output Targets 2008 • Preliminary trials to evaluate at least ten other vegetable species conducted at AVRDC organic farm • At least six varieties of cucumber, sweet pepper, and broccoli evaluated at AVRDC's organic farm • African eggplant and sweet pepper evaluated for resistance to soil-borne diseases under controlled conditions • Superior sweet pepper varieties under Tanzanian conditions evaluated Output Targets 2009 • Superior varieties of target crops suitable for organic cropping systems recommended • Superior varieties of African eggplant and sweet pepper recommended in Tanzania

Narrative	Objectively Verifiable Indicators
Activity 3.2 Develop Integrated Organic Production Technology (IOPT) for selected vegetables	Output Targets 2007 • Component techniques evaluated for vegetable soybean and tomato IOPT development, including pest, disease control, and fertilization at AVRDC organic farm • Component techniques information collected for cucumber, sweet pepper, and common cabbage IOPT development • Participatory trial to compare farmers' practices against improved IOPT initiated for African eggplant and sweet pepper in Tanzania • Constraints on pest management documented for tomato, vegetable soybean and common cabbage Output Targets 2008 • IOPT of vegetable soybean and tomato developed in Taiwan • Component techniques evaluated for cucumber, sweet pepper, and common cabbage IOPT development in Taiwan • Participatory trial to compare farmers' practices against improved IOPT conducted for African eggplant and sweet pepper in Tanzania • Constraints of organic seedling production identified • Constraints on pest management documented for cucumber and sweet pepper Output Targets 2009 • IOPT of cucumber, sweet pepper, and common cabbage developed in Taiwan • Various organic seedling production technologies evaluated • IOPT for African eggplant and sweet pepper production in Tanzania recommended
Activity 3.3 Develop best organic fertilization strategy (BOFT) for selected vegetables	Output Targets 2007 • Soil and crop quality and safety monitored when evaluating six fertilization strategies in a year-round cabbage-green manure-tomato rotation system • Organic starter solution technology (OSST) for cabbage and tomato designed and evaluated Output Targets 2008 • BOFT evaluated for common cabbage and cherry tomato in Taiwan • Soil and crop quality and safety monitored when evaluating six fertilization strategies in a year-round cucumber-leafy-chili pepper rotation system • Effects of organic starter solution on yield produce quality of cucumber and chili pepper evaluated in Taiwan • Organic starter solution production protocol for small-scale farmers developed and published • OSST developed for cabbage and tomato Output Targets 2009 • BOFT evaluated for cucumber and chili pepper in Taiwan • OSST developed for cucumber and chili pepper

Output 4: Improved vegetable production technologies disseminated

Narrative	Objectively Verifiable Indicators
Activity 4.1 Determine site-specific dissemination strategies, adapt improved technologies, and facilitate their upscaling using participatory methods	Output Targets 2007 • Participatory appraisals conducted in Central Java, Aceh, and Solomon Islands. • Dissemination strategies determined for Central Java, Aceh, and Solomon Islands • Farmer-participatory research trials conducted in Aceh, Central Java, and Solomon Islands to validate technology for dissemination Output Targets 2008 • Farmer-participatory research trials conducted in Aceh, Central Java, and , Solomon Islands to validate technology for dissemination • In Aceh, Indonesia, Training of Trainers (ToT), adapted Farmer Field Schools (FFS), and field days conducted and extension publications written Output Targets 2009 • Farmer-participatory research trials conducted in Central Java and the Solomon Islands to validate technologies for dissemination • Extension publications distributed in Aceh • In Central Java, field days conducted and extension publications written and distributed • In Solomon Islands, ToT conducted and FFS adapted

Narrative	Objectively Verifiable Indicators
Activity 4.2 Conduct special skills and degree training	Output Targets 2007 • One statistics and experimental design workshop conducted in Aceh • One baseline survey analysis training course conducted (socio-economist from Assessment Institute for Agricultural Technology, Indonesia) (HQ) • One training course on disease resistance screening techniques conducted (HQ) • One scientist from the Indonesian Vegetable Research Institute, Indonesia trained on pepper fungal diseases (HQ) • One PhD student from the Leyte State University, Philippines conducting research on chili pepper IDM (HQ) • One MSc student from National Pingtung University of Science and Technology, Taiwan conducting research on IPM of chili pepper aphids (HQ) • One PhD student from from Humboldt University, Germany conducting research on chemical ecology of striped flea beetle (HQ) • One BSc student from the University of the Philippines Los Baños conducting research on effect of acylsugars from wild tomato on tomato fruitworm and whitefly (HQ) • Managing Vegetable Production and Marketing training course conducted (candidate to be selected from Aceh) (ARC) Output Targets 2008 • One PhD student from Leyte State University, Philippines conducting research on chili pepper IDM (HQ) • One PhD student from University of Agricultural Sciences, India conducting research on the effect of Bt toxins on natural enemies of DBM (HQ) • Managing Vegetable Production and Marketing training course conducted (candidate to be selected from Aceh) (ARC)

Output 5: Impact of new production technologies assessed

Narrative	Objectively Verifiable Indicators
Activity 5.1 Conduct cost-benefit analysis of technology alternatives	Output Targets 2008 • Analyze and document costs and benefits of various crop management strategies for chili in Indonesia and develop recommendations for best practices • Analyze and document costs and benefits of various crop management strategies for vegetables in Solomon Islands and develop recommendations for best practices
Activity 5.2 Conduct ex-ante and ex-post impact assessments	Output Targets 2007 • Interview at least 180 small-scale vegetable farmers using qualitative and quantitative approaches to determine production costs and economic importance of vegetable production in Solomon Islands • Interview at least 240 small-scale farmers in Aceh, Indonesia to determine constraints and economic aspects of vegetable production • Interview at least 200 small-scale farmers in Indonesia to characterize farm systems, pesticide application, and production constraints in chili Output Targets 2008 • Interview at least 40 tomato growers in Cambodia to quantify impact of pre- and postharvest management practices • Interview at least 200 farmers each in Tanzania, Uganda, Malawi, and Rwanda to quantify impact of improved seed and production practices for IV using an economic surplus approach and by comparing ex-ante and ex-post data • Evaluate impact of adapted FFS in Aceh, Indonesia
	Output Targets 2009 • Interview at least 180 small-scale farmers using quantitative and qualitative approaches in Solomon Island to quantify impact of new cultural practices by comparing ex-ante and ex-post data and by using a livelihood model • Interview at least 200 small-scale chili farmers in Indonesia to determine impact of improved chili production technology on income, employment, environment, and yield stability, by using an economic surplus approach and by comparing ex-ante and ex-post data
Activity 5.3 Conduct studies to understand farmer behavior and determinants of adoption	Output Targets 2007 • Quantify farmers' use of pesticides on cauliflower and cabbage and analyze farmers' attitude towards GM vegetable crops in India Output Targets 2008 • Identify constraints on the adoption of modern chili technology in Indonesia

Output 6: Superior variety release and production and distribution of quality seeds facilitated

Narrative	Objectively Verifiable Indicators
Activity 6.1 Develop and disseminate of adaptive vegetable seed production, processing, and storage technology	Output Targets 2007 • Seed production sites and facilities established in Tanzania, Mali, Madagascar, and Cameroon • Technology for seed production and storage of Ethiopian mustard, spider-plant, vegetable cowpea and nightshade developed • Technical leaflet/brochure developed for each crop in English and local languages • At least one demonstration/field day on seed production conducted in each target country to promote improved varieties • Train at least 20 local seed producers and link them to seed dealers/companies and production groups Output Targets 2008 • Technology for seed production and storage of African eggplant, jute mallow, okra, and amaranth developed • Technical leaflet/brochure developed for each crop in English and local languages • At least one demonstration/field day on seed production conducted in each target country to promote improved varieties • Train at least 20 local seed producers and link them to seed dealers/companies and production groups Output Targets 2009 • Technology for seed production and storage of hyacinth bean, and pumpkin developed • Technical leaflet/brochure developed for each crop in English and local languages • At least one demonstration/field day on seed production conducted in each target country to promote improved varieties • Train at least 20 local seed producers and link them to seed dealers/companies and production groups

Narrative	Objectively Verifiable Indicators
Activity 6.2 Facilitate variety release and improvement of seed distribution chains	Output Targets 2007 • Protocols for evaluation and production technology developed, tested, and adapted in at least two sites per country in East and Southern Africa • Provide resources (seeds, protocols and budget) to at least two seed companies and NARES per country for evaluation of superior varieties in targeted countries • One database on superior vegetable varieties completed and distributed to seed producers in target countries • Draft operational plans on variety release developed jointly with partners • Support NARES to organize at least one Seed Diversity Fair in each target country in SSA to encourage sustainable seed trading Output Targets 2008 • Conduct participatory training workshop on vegetable seed regulation and release mechanisms at RCA • Update the database on superior vegetable varieties and distribute to seed producers in target countries • Superior variety exchanged among National Breeding Units in sub-Saharan Africa for potential release • Train seed dealers and companies on seed storage, packaging, and marketing • Support NARES to organize at least one Seed Diversity Fair in each target country in SSA to encourage sustainable seed trading • Forum for information sharing among seed dealers and distributors in main vegetable growing area organized in target countries Output Targets 2009 • Update the database on superior vegetable varieties and distribute to seed producers in target countries • Superior variety exchanged among National Breeding Units in sub-Saharan Africa for potential release • Train seed dealers and companies on seed storage, packaging and marketing • Support NARES to organize at least one Seed Diversity Fair in each target country in SSA to encourage sustainable seed trading • Forum for information sharing among seed dealers and distributors in main vegetable growing areas organized in target countries

7.4 Theme 4: Postharvest Management and Market Opportunities

Coordinator: Katinka Weinberger
Deputy: Germain Pichop

Vision
To develop postharvest technologies and provide information to market agents to enable them to participate in high value vegetable chains

Mission
To help small-scale farmers and market agents to overcome the constraints related to participation in high value crop supply chains. This involves understanding the postharvest technical requirements for vegetables, and providing technical solutions that are economically feasible. This must cover the entire supply chain to contribute to a better understanding of access to markets and barriers to entry, organization and coordination of chains, as well as market opportunities. We also aim to contribute to an enabling policy environment.

More specifically
- To provide low income farmers and other agents along the supply chain with varieties better suited to handling, shipping, and processing;
- To provide all agents along the supply chain with low-cost postharvest processing and packaging technologies;
- To develop models and training programs in postharvest management, value adding and micro-enterprise development for small-scale packaging and processing and to facilitate training for processors, marketers, researchers, and extension specialists;
- To contribute to a better understanding of the market impact of pesticide use in vegetables, and the economic viability of different production and post-production technologies, including postharvest applications, organic production, and transgenic crops;
- To conduct surveys to characterize and describe vegetable supply chains;
- To conduct consumer surveys to identify their quality and safety requirements for vegetables; and
- To help smallholder farmers to identify market opportunities by providing them with market information, skills and technologies to enable them to meet increasingly stringent product quality requirements for safe vegetable supply.

What will be needed to implement this mission over the next three years?
The postharvest program at AVRDC is relatively young and in the process of establishment. A key point for success will thus be the identification of suitable partners willing to collaborate with AVRDC and committed to creating a research and development platform, since AVRDC will continue to focus on technology transfer through local adaptation of available technologies and training rather than basic research at Headquarters. Postharvest management activities in the future could be expanded to include the development of pilot approaches for pesticide residue testing in supply chains and enforcement of safe production technologies. In Africa, organic vegetable production and its implications on domestic and export markets has been identified as an important research topic but funding needs to be secured to address this issue. Also, currently little of our work includes South Asia, and especially India, although the market evolving there is huge and could potentially offer many opportunities for poor farmers in the near future.

The Theme Logframe

Theme 4: Postharvest management and market opportunities

Goal: Poverty is reduced by increasing the profitable and efficient involvement of small-scale actors in vegetable chains.

Purpose: Constraints and opportunities understood, technologies and strategic approaches developed and implemented for gainful participation of small-scale actors in formal and informal vegetable supply chains.

Output 1: Results of research and development to minimize postharvest loss

Narrative	Objectively Verifiable Indicators
Activity 1.1 Identify and quantify postharvest loss	Output Targets 2007 • Needs and priorities for postharvest technologies in leafy vegetables assessed and documented based on surveys among at least 200 supply chain actors each in Cambodia, Lao PDR, and Vietnam • Survey on production practices and postharvest loss for chili conducted in Cambodia among at least 120 supply chain actors Output Targets 2008 • Key strategies for reduction of postharvest loss in leafy vegetables for Cambodia, Lao PDR, and Vietnam (CLV) identified based on survey among supply chain actors and key informants Output Targets 2009 • Review of the literature on vegetable postharvest loss in sub-Saharan Africa
Activity 1.2 Develop low-cost processing and postharvest technologies	Output Targets 2007 • At least three innovative low-cost postharvest technologies for tomato or chili in CLV countries developed and available for broad distribution in target communities • Postharvest research capability building and networking activities conducted Output Targets 2008 • At least three innovative low-cost postharvest technologies for leafy vegetables in CLV countries developed and available for broad distribution in target communities • Postharvest research capability building and networking activities conducted
Activity 1.3 Establish processing microenterprise concepts	Output Targets 2007 • Model enterprise for postharvest handling and processing industries, jointly with local small-scale entrepreneurs, established in Lao PDR Output Targets 2008 • Model enterprise for postharvest handling and processing industries, jointly with local small-scale entrepreneurs from Lao PDR successfully transferred to at least one other country in the region • Micro-enterprise concepts and strategies adaptable to sub-Saharan Africa assessed based on literature review • Barriers for the development of a small-scale processing sector in Kenya and Tanzania, especially for tomatoes, assessed
Activity 1.4 Develop training materials and conduct training courses	Output Targets 2007 • Postharvest training for at least 60 trainers and supply chain actors conducted for tomato and chili postharvest technologies in CLV countries Output Targets 2008 • Training Master Plan for postharvest training for leafy vegetables in CLV countries developed • Training materials for developed postharvest technologies for leafy vegetables formulated Output Targets 2009 • Postharvest training for leafy vegetables of at least 200 trainers, and subsequently 2000 farmers each in Cambodia, Lao PDR, and Vietnam
Activity 1.5 Conduct adoption studies	Output Targets 2008 • Impact of pre- and postharvest management practices quantified among at least 40 tomato farmers in Cambodia Output Targets 2009 • Determinants of adoption of improved market coordination mechanism in Kenya and Tanzania identified

Output 2: Results of research and development for improved market coordination

Narrative	Objectively Verifiable Indicators
Activity 2.1 Characterize supply chain	Output Targets 2007 • Market opportunities for leafy vegetables in poverty-stricken upland areas of Cambodia, Lao PDR, and Vietnam assessed and documented based on supply chain surveys among at least 200 actors per country • Supply chain for chili in Cambodia characterized based on survey among at least 120 agents of supply chains • Supply chain for organic vegetables characterized based on surveys with 200 small-scale organic vegetable farmers in different regions of Tanzania • Supply chains for indigenous vegetables characterized in Malawi, Rwanda, Uganda, and Tanzania • Urban and Peri-Urban IV supply chains in Benin, Côte d'Ivoire, Senegal, Kenya, South Africa, Tanzania, and Uganda characterized and documented • Workshops on IV marketing in sub-Saharan Africa Output Targets 2008 • Constraints and opportunities of sales for organic vegetables assessed for domestic and regional markets based on survey with distributors (10), retailers (20), specialized (5), and non-specialized outlets (10) each in Arusha and Dar-es-Salaam, Tanzania • Supply chain for organic vegetables characterized based on surveys with 200 small-scale organic vegetable farmers in one country in West Africa and Malawi • Supply chains for indigenous vegetables characterized in Mozambique • Market potential of new vegetable varieties in three market sites in Solomon Islands evaluated Output Targets 2009 • Constraints and opportunities of sales for organic vegetables assessed for domestic and regional markets in one country in West Africa and Malawi

Narrative	Objectively Verifiable Indicators
Activity 2.2 Establish enhanced market coordination mechanisms	Output Targets 2007 • Economic and social indicators for key actors in the supply chains of AIV and orange flesh sweetpotato (OFSP) in three Kenyan districts and Arumeru District (Tanzania) assessed at baseline • Bargaining power of farmers in informal vegetable markets in Tanzania and Kenya assessed Output Targets 2008 • Opportunities and constraints of contract production assessed for poor and marginalized vegetable producers in Vietnam • Opportunities identified and strategies developed for stronger incorporation of small-scale farmers in organic vegetable supply chains in Tanzania • Strategies developed to make market information accessible to small-scale farmers producing organic vegetables in sub-Saharan Africa • Evaluation of strategies to reinforce small-scale chain actors bargaining power based on literature review Output Targets 2009 • Economic and social indicators for key actors in the supply chains of AIV and OFSP in three Kenyan districts and Arumeru District (Tanzania) assessed at end of project

Output 3: Evaluation, analysis, and assessment of food safety issues

Narrative	Objectively Verifiable Indicators
Activity 3.1 Evaluate and analyze quality standards and enforcement mechanisms of food safety issues	Output Targets 2007 • Economic and institutional factors related to provision of quality and safety of fruit and vegetable products (FVP) in Vietnam analyzed Output Targets 2008 • Strategy for efficient deployment of genetically modified crops in India developed • Knowledge of quality and standards requirements by organic supply-chain actors assessed based on surveys in sub-Saharan Africa • Impact of international standards on domestic supply chain agents involved in the organic sector assessed based on surveys in pilot country Output Targets 2009 • Importance of standards and grades for the Kenyan and Tanzanian vegetable export sector assessed based on a quantitative survey among export oriented farmers, exporters, and international traders • Enforcement of standards in the domestic market of Tanzania and Kenya evaluated based on key informant interviews, market actors, and secondary data sources
Activity 3.2 Promote food safety issues	Output Targets 2008 • Existing national food safety programs in at least two countries of sub-Saharan Africa identified • Food safety training curricula and programs developed and promoted
Activity 3.3 Understand food safety hazards	Under development

7.5 Theme 5: Nutritional security, diet diversification, and human health

Coordinator: Ray-yu Yang
Deputy: to be assigned

Vision
To assess, improve, and promote the nutritional and nutraceutical values of indigenous vegetables in particular and to assist their adoption by resource-poor communities.

Mission
To develop efficient research methodologies for selecting vegetables with superior nutritional values – particularly indigenous vegetables. Those IVs which are easy to grow will be selected and recipes which preserve their high nutritional values will be developed. In cooperation with regional partners, both small-scale production and home preparation of specific IVs will be promoted to improve the nutrition of poor communities and the impact of this on community health will be evaluated. The nutritional assessment and promotion of vegetables will be expanded to include their nutraceutical values to resource-poor communities.

More specifically
- To develop vegetable nutrition research protocols using analytical equipment and models in the laboratory in close association with universities and nutrition research centers;
- To use high throughput methodologies for nutritional and quality evaluation of vegetables to assist breeding and crop management programs;
- To identify IVs which are easy to grow and process and have good nutritional or health promoting qualities;
- To develop IV recipes based on bioavailability studies and traditional preparations to preserve the available micronutrients as much as possible;
- To cooperate with local nutrition and agriculture extension workers in working with farmers, women's groups, and school children in the regional program areas, in order to promote the production of IVs in home gardens and to improve the IV recipes' nutritional value;
- To study and monitor the impact of increased vegetable consumption on nutritional health;
- To assess the nutraceutical values of vegetable germplasm from different regions of the world to develop an IV nutrient database; and
- To expand the study of methods to process IVs for long term micronutrient preservation, identify vegetables that improve immune functions, and target promotion of IVs to communities with high risk of infectious diseases such as HIV/AIDS.

What will be needed to achieve that vision over the next three years?
AVRDC works to improve nutrition and health through agriculture. The nutrition program has been closely linked with germplasm and breeding programs to identify, select, and improve vegetables for higher quality and nutrition. There is a need for adequate budgeting of germplasm selection for nutrient and bioactive rich accessions for our core crops, including our new program in cucurbits. To benefit resource poor community with these vegetables, we need to build stronger linkages with nutrition extension workers and incorporate improved vegetables lines and knowledge into nutrition programs at the local community, school, and even national levels. Staff specialized in community nutrition, stationed at our Regional Centers or Offices will help to identify key players such as Helen Keller, World Vision, NGO, and government nutrition programs and ensure good communications among agriculture, food, and nutrition activities. Our nutrition program has identified several IVs high in nutritional values and functional properties. Further studies are needed to identify their health benefits and modes of actions in immune response. This would require linkage with advanced laboratories and medical colleges.

The Theme Logframe

Theme 5: Nutritional security, diet diversification, and human health

Goal: Nutrition and health of rural and urban poor consumers improved through increased consumption of vegetables.

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

Output 1: Information on consumption pattern and consumer behavior

Narrative	Objectively Verifiable Indicators
Activity 1.1 Assess willingness to pay for food safety	Output Targets 2007 • Consumer demand for food safety in fruit and vegetables understood and quantified Output Targets 2008 • Consumer attitude towards genetically modified vegetables (cauliflower and cabbage case studies) and determining factors understood Output Targets 2009 • Consumer demand and willingness to pay for organic vegetables in SSA assessed
Activity 1.2 Assess consumption pattern and dietary strategies in sub-Saharan Africa	Output Targets 2007 • Activity 1.2 included in the work package 2 "Dietary diversity along the rural-urban continuum: dietary composition and the use and access to indigenous and naturalised food plants (INFPs)" under EU-VeggieMaMa (Realizing the potential of indigenous and naturalized food plants to address child and mother malnutrition along the rural-urban continuum in SSA) proposal Output Targets 2008 • Workplan and refined research protocols agreed among participants • Contribution and role of INFPs to diets and dietary diversity of households and target groups along the rural-urban continuum analyzed Output Targets 2009 • Contribution and role of INFPs to diets and dietary diversity of households and target groups along the rural-urban continuum analyzed and the dynamics of access and use of INFPs researched • Compositional and contextual factors which may influence the prevalence of INFPs and dietary diversity in a household's diet along the rural-urban continuum identified
Activity 1.3 Assess costs and benefits in sub-Saharan Africa	Output Targets 2007 • A work package (No. 6) entitled "Assessment of the costs and benefits of dietary diversification strategies for pregnant and lactating women and children under five through improved micronutrient supply from vegetable and fruit consumption" proposed, developed, and joined under EU-VeggieMaMa proposal Output Targets 2008 • Workplan and research protocols refined and agreed among project participants in EU project planning workshop • Burden of micronutrient malnutrition analyzed in the four study countries • Cost of production and marketing of selected high micronutrient vegetables and fruits in each study country evaluated Output Targets 2009 • Cost-benefit of interventions undertaken to address micronutrient malnutrition in the four countries assessed
Activity 1.4 Assess consumption pattern and willingness to pay for improved processed and packaged indigenous vegetables in West Africa	Output Targets 2007 • Survey of 450 households conducted to determine vegetable consumption pattern in West Africa, measure quantities consumed, and analyze attitudes towards vegetable consumption • Willingness to pay for improved processed and packed indigenous vegetables determined
Activity 1.5 Assess consumer's awareness on nutrition values and utilization of vegetables	Output Targets 2008 • Study on consumer's awareness on the use of AIV and orange-fleshed sweet potatoes in Kenya and Tanzania

Output 2. Measured nutritional and functional values and nutrition-improved preparation methods

Narrative	Objectively Verifiable Indicators
Activity 2.1 Conduct nutritional analysis of vegetables	Output Targets 2007 • Nutrient contents including protein, fiber, sugar, vitamins A, C, E, folates, calcium, iron, and zinc of African indigenous vegetable/ IV (30-40 accessions, 15-20 species) measured and documented • A work package (No. 3) entitled "Investigating nutritional values of INFPs, traditionally prepared dishes, and improved recipes for pregnant and lactating women, weaning, and children under five," proposed and developed under EU-VeggieMaMa proposal Output Targets 2008 • More AIV samples selected, collected, and assessed for nutrient content for expansion of database; nutrient datasheets prepared and combined with existing AVRDC nutrient database • Workplan and research protocols refined and agreed among project participants in EU Project Planning Workshop Output Targets 2009 • Brochures and leaflets detailing nutritional values of African IV prepared for dissemination • Freeze dried plant materials and dishes prepared by four country participants for nutritional analyses in South Africa and AVRDC; Nutrient contents (protein, carotenoids, iron, calcium, and folates) measured and documented for calculation of nutrient intake

Narrative	Objectively Verifiable Indicators
Activity 2.2 Conduct functional analysis	Output Targets 2007 • African IV (30-40 accessions, 15-20 species) prepared for phytochemical analyses • Activity 2.2 included in work package 3 under EU-VeggieMaMa proposal • A proposal "Identification of bitter gourd accessions with high and verified antidiabetic activity as a dietary approach to hyperglycemia for the tropics" developed and submitted to BMZ/GTZ Output Targets 2008 • Functional properties including flavonoid contents, antioxidant, and anti-microbial activities of 30-40 AIV evaluated and data included in nutrient datasheet • Workplan and research protocols refined and agreed among project participants in EU Project Planning Workshop • Bitter gourd accessions from AVRDC germplasm identified, planted, and fruits harvested for lab analyses; prevalent bitter gourd varieties surveyed in India, collected, freeze dried, and transferred to AVRDC for lab analyses; in vitro assays of anti-diabetic activity adopted Output Targets 2009 • Brochures and leaflets of nutritional values of AIV prepared for dissemination • Freeze dried plant materials prepared by four country participants for evaluation of positive and negative phytochemicals • Anti-diabetic activities of bitter gourd accessions and popular varieties in India assessed in vitro and 1-2 potential accessions evaluated in vivo
Activity 2.3 Establish mass-screening techniques for nutritional and quality analyses	Output Targets 2007 • Leafy vegetables for near infrared spectroscopy (NIRS) calibration collected, scanned with NIRS, and measured for protein and carotenoids Output Targets 2008 • Calibrations tested for protein and carotenoids and validation tested • Continuous sample/data collection for calibration test if validation is unsatisfactory Output Targets 2009 • Validation tested and calibration equations improved • Concept note/proposal developed for funding

Narrative	Objectively Verifiable Indicators
Activity 2.4 Develop nutrition-improved recipes and food preparation methods	Output Targets 2007 • Effects of African traditional food processing methods and simulated gastrointestinal digestion on carotenoids, iron, and flavonoids of vegetables investigated • Nutrient retention of vegetable dishes prepared by traditional and modified methods measured • Recipes designed based on survey of traditional methods and studies on nutrient retention and iron bioavailability • Activity 2.4 included in work package 3 under EU-VeggieMaMa proposal Output Targets 2008 • Recipe book prepared, published, and disseminated • Workplan and research protocols refined and agreed among project participants in the EU Project Planning Workshop Output Targets 2009 • Leaflets and nutrition brochures prepared and published • Nutrition retention evaluated for vegetable dishes prepared by African common food practices surveyed in the four countries • Improved cooking methods recommended to minimize nutrient loss • Recipe design in progress by four participating countries based on common food practices and project recommended methods

Output 3: Food-based intervention package

Narrative	Objectively Verifiable Indicators
Activity 3.1 Develop home garden package for increased production of African indigenous vegetables and priority exotic vegetables	Output Targets 2007 • Cultural practices for AIV production including spacing, use of fertilizers, harvesting methods, water requirement, propagation technique, and cropping system under investigation Output Targets 2008 • Cultural practices of AIV production in home garden recommended • Home garden designed based on improved AIV cultural practices • AIV home garden set-up for promotion Output Targets 2009 • AIV home garden technology package including IV seeds and training materials prepared for dissemination

Narrative	Objectively Verifiable Indicators
Activity 3.2 Develop home garden package for faster adoption of promising lines	Output Targets 2007 • Trainers trained for vegetable production in home gardening system Output Targets 2008 • At least two improved production technologies on-farm validated for faster adoption of promising lines Output Targets 2009 • At least two home gardens set-up in each country for demonstration and promotion
Activity 3.3 Develop food garden models for year-round access to fruits and vegetables	Output Targets 2007 • Activity 3.3 included in work package 5 entitled "Increasing access to, production and consumption of exotic and INFPs by pregnant and lactating women and children" under EU-VeggieMaMa proposal Output Targets 2008 • Workplan and research protocols refined and agreed among participants/collaborators in EU Project Planning Workshop Output Targets 2009 • Various models of food gardens that provide mothers and children with year-round access to a range of INFPs under investigation

Output 4: Dissemination and promotion of production, utilization and consumption of nutrient rich vegetables

Narrative	Objectively Verifiable Indicators
Activity 4.1 Conduct promotion campaigns/ events to encourage production, utilization and consumption of nutrient-rich vegetables	Output Targets 2007 • Frequent introductions and demonstrations of IV experimental gardens to trainees, visitors, and media at HQ and AVRDC-RCA to increase public awareness of African and Asian IV Output Targets 2008 • IV gardens at HQ and AVRDC-RCA rearranged to include different types of IVs and frequently introduced and demonstrated to trainees, visitors and media at HQ and AVRDC-RCA to increase public awareness of African and Asian IV • Consumer awareness campaign to promote AIV and orange-fleshed sweet potatoes • Promotion strategies developed by AVRDC and NARS to promote AVRDC lines to increase vegetable consumption in participating countries Output Targets 2009 • Frequent introductions and demonstrations of IV experimental gardens to trainees, visitors and media at HQ and AVRDC-RCA to increase public awareness of African and Asian IV • Promotion materials designed and promotion events planned by NARS to encourage production and consumption of nutrient-rich, AVRDC breeding lines

Narrative	Objectively Verifiable Indicators
Activity 4.2 Distribute seed kits for home garden production	Output Targets 2007 • Seed packs of AIV and priority exotic crops distributed to collaborating seed companies for on-site home garden set-up • Seed kits of AIV distributed to project target groups for project research activities and to local farmers and extension peoples for home gardening in participating countries Output Targets 2008 • Seed supply improved through seed distribution and promotion of the production of AIV and priority exotic crops in home gardens • Continued seed kits distribution to project partners for research activities and to local farmers and research-extension personnel Output Targets 2009 • Continued seed kit distribution to project partners for research activities, local farmers, and extension people
Activity 4.3 Conduct workshops and symposia	Output Targets 2007 • A workshop on “Market chains and consumer consumption trends for IV” organized by/at AVRDC-RCA Output Targets 2008 • A Symposium on “Underutilized plant species for food, nutrition, income, and sustainable development” organized by/at AVRDC-RCA Output Targets 2009 • Proposal in development for new funding
Activity 4.4 Conduct training courses on home garden production, utilization, and consumption of vegetables	Output Targets 2007 • Two 2 to 3-day training courses will be delivered per month at RCA and each participating country. Courses will cover home garden production amd processing and preservation of vegetables, to be provided mainly for women groups, small scale farmers, NGO personnel, and agricultural/nutrition researchers and extensionists Output Targets 2008 • Two 2 to 3-day training courses will be delivered per month at RCA and each participating country. Courses will cover home garden production amd processing and preservation of vegetables, to be provided mainly for women groups, small scale farmers, NGO personnel, and agricultural/nutrition researchers and extensionists Output Targets 2009 • Two 2 to 3-day training courses will be delivered per month at RCA and each participating country. Courses will cover home garden production amd processing and preservation of vegetables, to be provided mainly for women groups, small scale farmers, NGO personnel, and agricultural/nutrition researchers and extensionists

8. GLOBAL SUPPORT SERVICES

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As the number of scientists working at the Center and the size of the regional activities expand, the need for more sophisticated support services also expands. Over the next three years, the number of international scientific staff and senior consultants employed by the Center is expected to grow from around 30 in 2005 to closer to 60 by late 2007 and this will require more effective and efficient support services, particularly from Human Resources, Communications, and Finance.

In 2007, a Human Resources (HR) Manager was employed to manage recruitment, the processes for staff appraisal, promotion procedures, review, and revision of personnel policies, and the identification of opportunities for staff development. This is a new position as HR activities were used to be handled by the Center management.

New Communications staff members were appointed in 2006 and the new Communications group integrates the functions of the former Communications and Training Office with the Computer Services Unit and the Library Services Unit. A growing international center must maintain good internal communications to maintain a common sense of purpose. The Center’s headquarters has high bandwidth connectivity to the internet and there is a need to expand the capabilities and functions of its e-mail system, intranet, internet, and videoconferencing services. The library must also expand its services to proactively supply information to not only the Center’s staff but key partners as well. The Center must raise its international scientific profile and this will mean greater emphases on publications and utilization of services such as the International Society of Horticulture Sciences (ISHS) publication system, in order to raise its global profile.

The Center’s financial services need to be strengthened to increase efficiency and to reduce risk. In 2007 an Internal Auditor was appointed so that regular auditing of the Regional Centers and Offices will become a routine. With the approaching retirement of the Center’s Comptroller, a new position of Finance Manager will be advertised. New commercial software with broad capabilities and elaborate security systems will be adopted to enable quicker turnaround of financial reporting and for greater accessibility of financial information by scientists and management throughout the Center’s locations.

In 2007, the Center will also undergo its 7th External Program and Management Review with a particular focus on its research and development activities and their support services. This will help ensure that the Center’s expansion continues to meet the needs of its clients for global vegetable research and development.

9. LIST OF STAFF - 2007

Regular Staff			
Name	Position Title	Location	Nationality
AKYEAMPONG, Ekow	Coordinator	AVRDC's Sub-Regional Office for West and Central Africa (Bamako, Mali)	Ghana
ALI, Mubarik**	Agricultural Economist	Headquarters	Pakistan
BHATTARAI, Madhusudan	Agricultural Economist	Headquarters	Nepal
CHADHA, M.L.	Director	AVRDC-Regional Center for South Asia (Hyderabad, India)	India
CHANG, Yin-Fu	Deputy Director General for Administration and Services	Headquarters	Taiwan
DE LA PEÑA, Robert	Molecular Plant Breeder	Headquarters	Philippines
EASDOWN, Warwick	Head of Communications	Headquarters	Australia
ENGLE, Liwayway M.	Geneticist	Headquarters	Philippines
GNIFFKE, Paul A.	Plant Breeder	Headquarters	USA
GREEN, Sylvia K.	Plant Pathologist	Headquarters	Germany
HANSCHKE, Oliver	Information and Media Associate	Headquarters	Germany
HANSON, Peter M.	Plant Breeder	Headquarters	USA
HUGHES, Jacqueline d'A.	Deputy Director General for Research	Headquarters	UK
KANZA, George	Financial Administrator	AVRDC - Regional Center for Africa (Arusha, Tanzania)	Tanzania
KUMAR, Sanjeet	Vegetable Breeder	ICRISAT Sahelian Center (Niamey, Niger)	India
KUO, C. George*	Director of International Cooperation Office	Headquarters	Canada
LIU, Chien-An*	Molecular Biologist	Headquarters	Taiwan
LU, Vincent	Internal Auditor	Headquarters	Taiwan
LUMPKIN, Thomas A.	Director General	Headquarters	USA
LUTHER, Gregory C.	IPM/Development Specialist	Headquarters	USA
LUTHER, Kartini	Assistant to Deputy Director General for Research	Headquarters	USA

Regular Staff			
Name	Position Title	Location	Nationality
OLUOCH, Mel O.	Training Specialist	AVRDC – Regional Center for Africa (Arusha, Tanzania)	Kenya
OOI, Peter	Director	AVRDC-Asian Regional Center (Bangkok, Thailand)	Malaysia
PALADA, Manuel C.	Vegetable Production/ Ecosystem Specialist	Headquarters	USA
RAMASAMY, Srinivasan	Assistant Scientist (Entomology)	Headquarters	India
SILUÉ, Drissa	Associate Plant Pathologist	AVRDC – Regional Center for Africa (Arusha, Tanzania)	Côte d'Ivoire
SUN, Zhanyong	Cucurbit Plant Breeder	Headquarters	People's Republic of China
TAN-HABACON, Lilia	Human Resources Manager	Headquarters	Philippines
VIRCHOW, Detlef	Director	AVRDC – Regional Center for Africa (Arusha, Tanzania)	Germany
WANG, Jaw-fen	Associate Plant Pathologist	Headquarters	Taiwan
WANG, Tien-chen	Mycologist	Headquarters	Taiwan
WEINBERGER, Katinka	Assistant Scientist-Socio-Economist	Headquarters	Germany
YANG, Ray-yu	Nutritionist	Headquarters	Taiwan

Project Staff			
Name	Position Title	Location	Nationality
HELSEN, Jan	vBSS Project Administrative Manager	AVRDC – Regional Center for Africa (Arusha, Tanzania)	Belgium
JUROSZEK, Peter	Post-Doctoral Fellow (Organic Vegetable Production)	Headquarters	Germany
KADIRVEL, Palchamy	Post-Doctoral Fellow (Molecular Breeding and Entomology)	Headquarters	India
NONO-WOMDIM, Rémi	vBSS Liaison Officer for Tanzania and vBSS Project Research Manager	AVRDC – Regional Center for Africa (Arusha, Tanzania)	Cameroon
PICHOP, Germain N.	Post-Doctoral Fellow (Socio-economist/ Agribusiness)	AVRDC – Regional Center for Africa (Arusha, Tanzania)	Cameroon
PLETZIGER, Stefan	Associate Scientist-Economist	AVRDC – Regional Center for Africa (Arusha, Tanzania)	Germany
RAKOTOARISOA, Benjamin E.	vBSS Liaison Officer for Madagascar	AVRDC – Regional Center for Africa (Arusha, Tanzania)	Madagascar
SAXENA, Shilpi	Post-Doctoral Fellow (Geographer)	AVRDC – Regional Center for Africa (Arusha, Tanzania)	The Netherlands
VENKATESAN, Sengoda	Post-Doctoral Fellow (Plant Virology and Molecular Genetics)	Headquarters	India

Consultant Staff			
Name	Position Title	Location	Nationality
ABDOURHAMANE, Issoufou K.	Plant Pathologist	AVRDC Sub-Regional Office for West and Central Africa (Bamako, Mali)	Niger
ACEDO Jr., Antonio	Regional Project Coordinator (ADB-RETA 6208/6376 project)	Vientiane, Lao PDR	Philippines
CLAVERO, Christie S.	Assistant Media Specialist	Headquarters	Philippines
DIBIYANTORO, Anna	Site Coordinator (ACIAR/ Chili IDM project)	Tegal, Indonesia	Indonesia
HAMILTON, Kathryn	Special Projects Coordinator	Headquarters	UK
KAISER, Markus	Grant Development Coordinator	Headquarters	Germany
KYI, Win Win	Small-scale Enterprise Advisor	Vientiane, Lao PDR	Myanmar
LEDESMA, Dolores R.	Specialist for Statistics and Database Development	Headquarters	Philippines
MAVLYANOVA, Ravza F.	Regional Coordinator	AVRDC-Central Asia and Caucasus Program (Tashkent, Uzbekistan)	Uzbekistan

Seconded Scientists			
Name	Position Title	Location	Nationality
KAHANE, Rémi	Executive Secretary, Global Horticulture Initiative	AVRDC – Regional Center for Africa (Arusha, Tanzania)	France
TAKAHASHI, Motoki*	Plant Breeder	Headquarters	Japan
WOO, Jong-Gyu	Plant Breeder	Headquarters	Korea

* No longer with AVRDC-The World Vegetable Center after August 2007
** On two-year leave

10. BUDGET

The following tables show the evolution of the Center's budget over the period 2006–2009 along with sources of funding and allocation of finances to the thematic research and development activities.

Table 1 shows the final breakdown of the 2006 budget along with allocations to themes, Global Horticulture Initiative, and administration.

Table 2 shows how the estimated 2007 budget differs from the 2006 budget.

Table 3 shows the main sources of revenue between the 2006 and 2007 budgets.

Table 4 shows the expected budgets for the next three years and how the allocations to themes are expected to change. By 2009 the amount allocated to research themes will have increased by 13–34% (Theme 1 and Theme 3 respectively) while the amount allocated to administration is expected to decline by about 4%.

The Global Horticulture Initiative is currently included in the Center's budget, but this will change over time as it develops as an independent entity which is due to take place in 2007. The total budget for 2006 is approximately USD 0.4 million and consultations with Taiwan Ministry of Foreign Affairs are continuing to organize the appropriate mechanism to fund the remaining USD 2 million promised which will form the majority of the expected 2007 budget. Details on how the initiative has been constructed and funded are shown in between Tables 2 and 3.

Table 1. Financial activities for the twelve months ending 31 December 2006

	2006 Actual		Budget (USD '000) (Board Approved)	
Revenues	**12,626,320**		**15,306**	
Expenditures				
Personnel	2,568,521	22%	2,672	17%
- International	3,871,443	33%	3,769	24%
- Local				
Operating expenses				
- Field labor	760,385	6%	670	4%
- Supplies	1,565,419	13%	1,878	12%
- Travel	292,328	2%	567	4%
- Training and workshop	871,283	7%	1,096	7%
- General expenses/overheads	938,903	8%	1,091	7%
Contract outreach research	806,882	7%	1,545	10%
Equipment, facilities, and renovations	147,956	1%	500	3%
Global Horticulture Initiative			1,700	11%
Total	**11,823,120**	**100%**	**15,488**	**100%**
Changes in net assets	**803,200**		**-182**	
Net assets at beginning of 2006	**182,316**		**182**	
Changes in net assets	**803,200**			
	985,516			
Commitment-				
Renovation cost of administration building	**985,516**			
Net assets at end of 2006	**0**	[a/]	**0**	

[a/] Excludes working capital fund of USD 1,000,000 at the end of 2006

Expenditures by strategy themes and service				
I. Themes				
1. Germplasm conservation, evaluation, and gene discovery	2,202,877	17%	2,627	17%
2. Genetic enhancement and varietal development of vegetables	1,978,590	15%	2,425	16%
3. Seed and safe vegetable production systems	968,395	8%	1,617	10%
4. Postharvest management and market opportunities	856,151	7%	1,415	9%
5. Nutritional security, diet diversification, and human health	1,754,281	14%	2,021	13%
II. Global Horticulture Initiative			**1,700**	**11%**
III. Administration and Services	**5,048,323***	**39%**	**3,683**	**24%**
Total	**12,808,617**	**100%**	**15,488**	**100%**

*Includes the commitment to the renovation cost

Table 2. 2007 final budget estimate

USD '000

	2007 Estimate		2006 Actual		2006 Budget	
Revenues	**17,767**		**12,626**		**15,306**	
Allocations by Objects						
Personnel						
- International	3,593	20%	2,569	20%	2,672	17%
- Local	3,950	22%	3,871	30%	3,769	24%
Operating expenses						
- Field labor	1,126	6%	760	6%	670	4%
- Supplies	2,950	17%	1,565	12%	1,878	12%
- Travel	943	5%	292	2%	567	4%
- Training and workshop	1,162	7%	871	7%	1,096	7%
- General expenses	1,553	9%	939	7%	1,091	7%
Contract outreach research	1,040	6%	807	6%	1,545	10%
Equipment, facilities and renovations	1,450	8%	1,134	9%	500	3%
Global Horticulture Initiative					1,700	11%
Total	**17,767**	**100%**	**12,808**	**100%**	**15,488**	**100%**
Changes in Net Assets	**0**		**-182**		**-182**	
Changes at Beginning of Year	0		182		182	
Changes in Net Assets	0		-182		-182	
			0		0	
Net assets at End of Year	**0**	[2/]	**0**	[a/]	**0**	

[a/] Excludes working capital fund of USD 1,000,000 at the end of 2007

Budget Allocation by Themes						
Themes						
1. Germplasm conservation, evaluation and gene discovery	3,649	21%	2,146	17%	2,627	17%
2. Genetic enhancement and varietal development of vegetables	3,368	19%	2,020	16%	2,425	16%
3. Seed and safe vegetable production systems	2,305	13%	1,010	8%	1,617	10%
4. Postharvest management and market opportunities	2,011	11%	988	8%	1,415	9%
5. Nutritional security, diet diversification and human health	2,526	14%	1,596	12%	2,021	13%
Global Horticulture Initiative					**1,700**	**11%**
Administration and Services	**3,908**	**22%**	**5,048**	**39%**	**3,683**	**24%**
Total	**17,767**	**100%**	**12,808**	**100%**	**15,488**	**100%**

Global Horticulture Initiative

Funded by
Ministry of Foreign Affairs (MOFA) Taiwan

Total budget
USD 400,000

www.avrdc.org

Project duration
September 2006 – August 2007

AVRDC staff involved
Thomas Lumpkin (Director General; Chair, GlobalHort Board of Directors), Jackie Hughes (Deputy Director General - Research), Yin-Fu Chang (Deputy Director General - Administration & Services), Warwick Easdown (Head, Communications), Oliver Hanschke (Information & Media Associate, Communications)

Seconded scientist
Rémi Kahane (Executive Secretary, GlobalHort)

Partner institutes
Center for International Cooperation in Agricultural Research for Development (CIRAD), France; MOFA, Taiwan

Executive summary

Advances in biological sciences and in information and communication technologies provide unprecedented opportunities for the scientific community to take collective action for impact on poverty and malnutrition. The Global Horticulture Initiative (GlobalHort) will utilize these advances to enlist a consortium of national and international organizations, institutions, and agencies working towards the common goal of improving global health and prosperity through horticultural sciences and research for development programs.

Globalization, trade liberalization, and changes in consumer demand are creating new market opportunities for farmers and landless laborers especially through horticultural systems and supply chains in the tropics and subtropics. Many cereal farmers are already converting a portion of their land into production of high value horticultural crops. A strong horticulture sector is an engine for economic growth: it creates jobs, supports agri-businesses, and generates income to a greater degree than staple crops. Furthermore, horticultural crops can provide the micronutrients that are essential, yet lacking in the diets of half of the world's population.

The mission of the GlobalHort is to improve the health and income of the poor in developing countries through sustainable, demand driven, horticultural production, processing, and marketing systems. The GlobalHort will promote higher education and output-oriented

research, and expand outreach activities through broad-based partnerships. Information and communication technologies will substitute for much of the conventional physical infrastructure of a more traditional institutional model. It will energize global systems of horticultural research, production, processing, and trade. It will also enable the formulation of policies and programs that support small-scale farmers and horticultural commerce both domestically and internationally.

Four core activities are envisaged and will develop according to the allocated staff:

- Promoting research for development projects through complementary grants programs;
- Networking the world's fragmented community of horticulture for development players;
- Coordinating training and capacity building in both private and public sectors; and
- Advocating and lobbying for horticulture and horticultural sciences.

Priority crops and research themes will be driven by demand. Using the internet as the medium, the coordination team will develop information management and interactive tools to organize tenders and calls for research, training, and capacity building in a more integrated rather than competitive process. Activities will focus on sub-Saharan Africa and South Asia, with secondary emphases in Central Asia, Southeast Asia, and Latin America.

To significantly contribute to the goal of alleviating poverty and malnutrition, considerable investment in horticulture is required. Outputs from the Global Horticulture Initiative will increase support opportunities for horticultural research, information exchange, and capacity building. Higher awareness of all horticulture issues will contribute to improve nutritional security (especially for women and children), by increasing production and consumption of fruits and vegetables, reducing malnutrition and childhood mortality, and enhancing environmental quality and human health.

Table 3. Breakdown of 2007 revenues

Donor	2007 Proposal		2006 Actual		2006 Budget (Board Approved)	
Unrestricted Core						
Taiwan	5,533		5,533		5,571	
USAID	291		582		362	
UK-DFID	1,267		1,267		1,246	
Japan	42		42		53	
Korea	75		8		75	
Thailand	138		138		118	
Philippines	0		0			
France	96		179		84	
APSA	150		159		150	
Other revenues and support	950		555		550	
Sub-total	**8,542**	**48%**	**8,463**	**67%**	**8,209**	**54%**
Restricted Core						
Renovation, facilities and equipment						
Taiwan/MOFA			272		269	
Global Horticulture Initiative and other global activities						
Taiwan/MOFA						
- Strengthening the Center's global activities	1,000				1,000	
- Global Horticulture Initiative (see Table 4)						
Research activities						
ACIAR	413		43		39	
Asian Development Bank	347		506		576	
APSA	20				20	
CropLife Asia	20		5		25	
European Union	31		17		50	
East-West International BV	50					
France			46		134	
Gates Foundation	4,410					
Germany/ES	99		33		114	
Germany/BMZ/GTZ	1,371		1,333		1,418	
Japan	59		45		34	
Korea/RDA	30		35		54	
Philippines	33		22		58	
RALF	17		63		55	
Rockefeller Foundation	71		36		66	
Taiwan, COA, & NSC	677		828		644	
Swiss/SDC	233		338		370	
TOC	4		38		27	
UK/DFID	72		106		174	
USAID	233		347		245	
USA/USDA	10		0			
Training and Others	25		50		25	
Sub-total	**9,225**	**52%**	**4,163**	**44%**	**7,097**	**46%**
Contribution in-kind						
Japan [1/]	120		120		120	
Korea [1/]	50		50		50	
GTZ/CIM [2/]						
GTZ/CIM/ICRISAT/France [3/]						
Total revenues	**17,767**	**100%**	**12,626**	**100%**	**15,306**	**100%**

[1/] Outposted scientist (in-kind); [2/] Director and 2 economists, Regional Center for Africa, are partially funded by GTZ/CIM Program;
[3/] GTZ/CIM/ICRISAT/France - 1 position in 2007; GTZ/CIM - 1 position in 2007

Table 4. Budget projection for 2007-2009

USD '000

	2007 Estimate	2008 Projection	2009 Projection
Budget Allocation by Objects			
Personnel			
- IRS	3,593	4,000	4,100
- Local	3,950	4,200	4,650
Operations			
- Field labor	1,126	1,250	1,400
- Supplies & services	2,950	3,200	3,500
- Travel	943	1,100	1,200
- Training and workshop	1,162	1,250	1,400
- General expenses	1,553	1,700	1,900
Contract outreach research	1,040	1,150	1,300
Equipment, renovation and facilities	1,450	1,350	1,250
Total	**17,767**	**19,200**	**20,700**
Budget Allocation by Themes and Administration			
I. Themes			
1. Germplasm conservation, evaluation, and gene discovery	3,649	3,820	4,120
2. Genetic enhancement and varietal development of vegetables	3,368	3,680	3,950
3. Seed and safe vegetable production systems	2,305	2,720	3,090
4. Postharvest management and market opportunities	2,011	2,360	2,640
5. Nutritional security, diet diversification, and human health	2,526	2,870	3,140
II. Administration and Services	3,908	3,750	3,760
Total	**17,767**	**19,200**	**20,700**

ACRONYMS and ABBREVIATIONS

AB-QTL	Advanced Backcross Quantitative Trait Loci
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AIV	African indigenous vegetables
APSA	Asia and Pacific Seed Association
ARC	Asian Regional Center
ASEAN	Association of South-East Asian Nations
AVGRIS	AVRDC Vegetable Genetic Resources Information System
BAPHIQ	Bureau of Animal and Plant Health Inspection and Quarantine
BFT	balanced fertilization technology
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
BOFT	best organic fertilization strategy
Bt	*Bacillus thuringiensis*
BW	bacterial wilt
CGIAR	Consultative Group on International Agricultural Research
ChiVMV	Chili veinal mottle virus
CIM	Centrum für internationale Migration und Entwicklung
CIP	Centro Internacional de la Papa
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
CLV	Cambodia, Lao PDR, and Vietnam
CMS	cytoplasmic male sterility
CMV	Cucumber mosaic virus
COA	Council of Agriculture
DBM	diamondback moth
DFID	Department for International Development
DDG-A&S	Deputy Director General-Administration & Services
DDG-R	Deputy Director General-Research
DG	Director General
DH	double haploid
DNA	deoxyribonucleic acid
FFS	Farmer Field Schools
FVP	fruit and vegetable products
GAP	good agricultural practices
GIS	geographic information system
GlobalHort/GHI	Global Horticulture Initiative
GM	genetically modified
GMO	genetically modified organism
GMS	Greater Mekong Subregion
GNI	Gross National Income

GRSU	Genetic Resources and Seed Unit
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HQ	AVRDC's headquarters
HR	Human Resources
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICM	integrated crop management
ICSM	integrated crop and soil management
ICPN	International Chili Pepper Nursery
IDE	International Development Enterprises
IDM	integrated disease management
INFP	indigenous and naturalised food plants
IOPT	integrated organic production technology
IPR	intellectual property rights
IPM	integrated pest management
IRS	internationally recruited staff
ISFM	integrated soil fertility management
ISHS	International Society for Horticulture Sciences
ISPN	International Sweet Pepper Nursery
IT	information technology
IV	indigenous vegetable
JIRCAS	Japan International Research Center for Agricultural Sciences
LPB	legume pod borer
MAS	marker assisted selection
MOFA	Ministry of Foreign Affairs
MTA	Material Transfer Agreement
MTP	medium-term plan
MvNPV	*Maruca vitrata* nuclear polyhedrosis virus
NARES	National Agricultural Research and Extension System
NARS	National Agricultural Research System
NBU	National breeding unit
NGOs	non-governmental organizations
NSC	National Science Council
OP	open pollinated
OFSP	orange-flesh sweetpotato
OSST	organic starter solution technology
PB	Phytophthora blight
PLV	preferred locally adapted variety
QTL	quantitative trait loci
RALF	Research in Alternative Livelihoods Fund
RCA	Regional Center for Africa
RCSA	Regional Center for South Asia
RDA	Rural Development Administration
SDC	Swiss Development Center
SI	Solomon Islands
SSA	sub-Saharan Africa
SST	starter solution technology
TOC	The Organic Center
ToT	Training of Trainers
TuMV	Turnip mosaic virus
TYLCV	Tomato yellow leaf curl virus
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
vBSS	Vegetable Breeding and Seed Systems
WARDA	Africa Rice Center
WTG	whitefly-transmitted geminiviruses