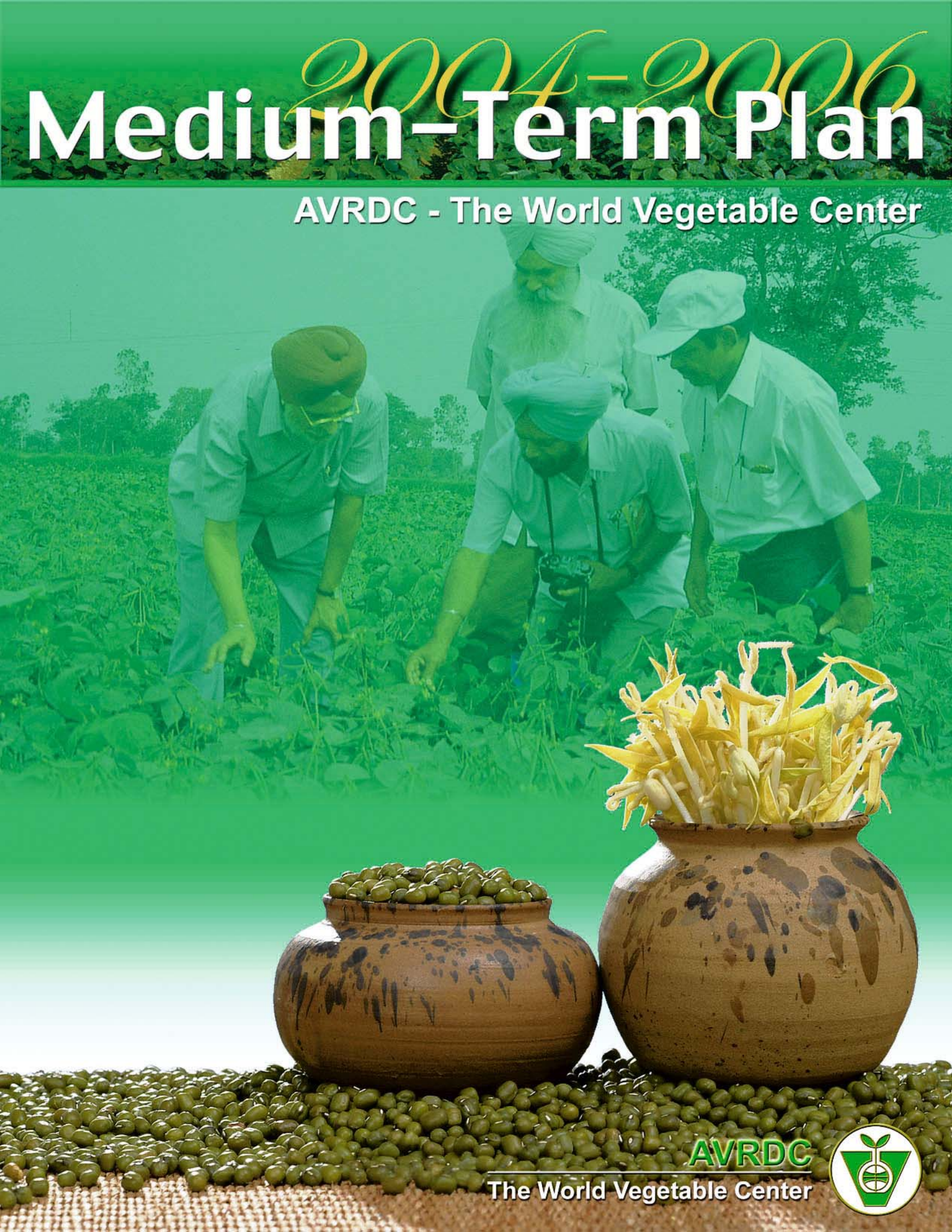
2004–2006 Medium-Term Plan

AVRDC - The World Vegetable Center



AVRDC
The World Vegetable Center

AVRDC – the World Vegetable Center is an international not-for-profit organization committed to improved nutrition, job creation and food safety for the world's poor through research, development and training.

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About the cover:

A "mungbean revolution" is spreading throughout Asia. Millions of farmers are adding AVRDC's early maturing mungbean varieties into their cropping systems. For more information, please see page 7.

AVRDC Medium-Term Plan 2004–2006

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Foreword

AVRDC – the World Vegetable Center is pleased to present our accomplishments for the past year and plans for the immediate future. Year 2003 saw the development of significant momentum and progress in the rebirth of our center. Declining trend lines in both funding and scientific staffing have been reversed, partner and donor interest revived, technical upgrading and renovation initiated, global outreach expanded, molecular and information technology emphasized, and focus on the world's poorest communities sharpened.

Last year was a productive year for our team of scientists. Impressive advances were made in many areas of science, including molecular genetics, germplasm management and sustainable crop production. These enhanced technologies are already increasing production of safe vegetables, improving human nutrition and creating jobs in developing countries. I invite you to read about these impacts, beginning on page 4. Also, please note the recent impacts of our mungbean breeding program, as described in a feature story on page 7. Millions of South Asian farmers will be adding the Center's early maturing mungbeans into their cropping systems this year.

Despite our recent achievements, the needs in the developing world for vegetable R&D are greater than ever. Nearly three billion people are living on less than 2 USD per day. Unemployment and poverty are rampant and increasing in sub-Saharan Africa. Malnutrition continues unabated as billions of people suffer from micronutrient deficiencies, in large part due to inadequate access to vegetables. AVRDC – the World Vegetable Center and many other international organizations such as the World Bank and FAO recognize that promoting horticulture, especially vegetables, can contribute significantly in solving these problems. Such promotion of vegetables will create jobs, enhance income and boost human health.

At AVRDC, we are targeting greater efforts in delivering our technologies to regions of distress, and using a more precise research focus for increased productivity, reduced pesticide input, and market development. Other emerging areas of emphasis include establishing strategic alliances for low-cost drip irrigation systems, strengthening the private sector to deliver our products, developing scientifically verified organic options, and improving post-harvest technologies.

Our new approach also means a new geographic view for the Center. No longer limited to tropical Asia, we have recently expanded our programs into West Africa and are forging networks of partners in Central Asia and Central America. As the world's only international center focused on vegetables, we will not neglect any area that calls for our expertise and technologies.

I am pleased to share with you the AVRDC *Medium-Term Plan 2004–2006*. This document was developed with the input of AVRDC staff and its networks of partners. Using a concise and illustrated format, the plan presents an update of the Center, emerging trends in the vegetable sector, and our strategic approaches in empowering needy farmers in the developing world. I invite you to review this document and partner with us to alleviate poverty and malnutrition in the developing world.

Dr. Thomas A. Lumpkin
Director General

Organizational Statement

Our Mission

Reduce malnutrition and poverty among the poor through vegetable research and development

Our Strategy

Build partnerships and mobilize resources from private and public sectors to promote vegetable production and consumption in the developing world. Our research will contribute to:

- Increased productivity of the vegetable sector
- Equity in economic development in favor of rural and urban poor
- Healthy and more diversified diets for low-income families
- Environmentally friendly and safe production of vegetables
- Improved sustainability of cropping systems

Our Core Expertise

- Management of diverse vegetable germplasm
- Innovations in variety improvement, including the use of molecular tools
- Sustainable production of safe and nutritious vegetables in the tropics
- Networks of strategic alliances for generating and sharing knowledge
- Analysis of direct and indirect impacts of vegetables

Our Unique Role

AVRDC functions as a catalyst to:

- Build international and interdisciplinary coalitions that engage in vegetable and nutrition issues
- Generate and disseminate germplasm and technology that address needs of the poor
- Collect, characterize, and safeguard vegetable germplasm resources for worldwide use
- Provide globally accessible, user-friendly, science-based, appropriate technology

Chapter 1

Overview

Introduction

This is an important time in vegetable research and development. The challenges are enormous—two billion persons suffer from malnutrition due to inadequate consumption of vegetables. Over one billion persons live on only 1 USD or less per day, and the incidence of poverty in Africa continues to rise. And yet, the opportunities for impact are greater than ever—powerful new biotechnologies and partnerships are creating new vistas in science that can lead to unprecedented impacts.

AVRDC – the World Vegetable Center is the leading international center for vegetable research and development. Its mission is to reduce poverty and malnutrition in developing countries through improved production and consumption of vegetables. The following document is a compilation of highlights from our *Medium-Term Plan: 2004–2006*. The plan was developed with the input of our staff and complements our long-term strategy, *Empowering Small-Scale Farmers for Knowledge-Based Agriculture: Strategy 2010*. We invite you to read the complete versions of both our medium-term and long-term plans, which are accessible on the AVRDC website at <www.avrdc.org>. The following document describes highlights of our recent successes, worldwide vegetable production and consumption trends, our financial outlook, and our research and development goals for 2004–2006.

Vegetables are vital in our lives

Vegetables are vital for **healthy diets**. Vegetables are not a luxury—they are absolutely essential for human health.[1] Vegetables are rich sources of many essential micronutrients, including vitamins C and K, folate, thiamine, carotenes, several minerals, and dietary fiber. In fact, vegetables are the most sustainable and affordable dietary sources of micronutrients.

Vegetables are essential for healthy diets and productive lives.

Malnutrition cannot be solved by simply producing higher quantities of food. The *quality* of food, and specifically, the nutrient content of the food is just as important. For example, rice, wheat and maize are among the world's most consumed staple foods. However it would require a person to eat more than 5 kg of either

of these staples each day to satisfy their requirements for vitamin A and iron. This is impossible, both to grow and consume. Consuming a tomato and a few spoonfuls of greens, for example, is a much more reasonable option for satisfying one's daily micronutrient requirements.

All children deserve a healthy start to their lives.

Vegetables are vital for **productive lives**. Healthy diets improve the learning capacity and productivity of workers. In contrast, poor diets lead to poor mental and physical development, poor performance in school, poor productivity in the workplace, and the likelihood of poverty in future generations.[2] All children deserve a healthy start to their lives—anything less is unacceptable.

But not enough vegetables are available, especially to poor families. Two billion persons, the vast majority of whom are women and children, do not have adequate access to the micronutrient-rich vegetables they need.[3] More vegetables are required to nourish these and all persons. Vegetables are vital—they are not a luxury.

Vegetable production creates jobs and economic growth.

Vegetables are vital for **strong economies**. Vegetable production provides jobs—more jobs compared to cereal production, per hectare of production.[4] Vegetable production supports agribusiness and related service industries, thereby creating economic opportunities. Vegetable production diversifies and generates farm income, usually to a greater degree than other agricultural products.[5,6] Also, vegetable production develops management and leadership skills among farmers.[7] A strong vegetable sector is an engine for economic growth.

AVRDC – the World Vegetable Center

AVRDC has a special role. It is a catalyst to bring international and interdisciplinary teams together to develop technologies that empower farmers and sustain the environment. We build partnerships and mobilize resources from both private and public sectors to address problems related to vegetable production and consumption. This strategy leads to increased productivity of farmers, sustainable and safe production of vegetables, and healthy diets for low-income families. Our center is recognized as a world leader in the following areas related to vegetable R&D:

1. Management of diverse vegetable germplasm;
2. Innovations in crop improvement, including the use of molecular tools;
3. Sustainable production of safe and nutritious vegetables in the tropics;
4. Networks of strategic alliances for generating and sharing knowledge; and
5. Analysis of direct and indirect impacts of vegetables.

As we look to the future, AVRDC will focus on its expertise and build upon its strengths. At the same time, the Center will reach out to utilize the complementary expertise of partners. Extending such partnerships, including with the private sector, is vital for maximizing impact.

Organizational structure and partnerships

AVRDC has streamlined its organizational structure to become more efficient, flexible and responsive to project-driven development. A new position was created, the Deputy Director General for Research, to oversee research activities and to organize project-based teams. AVRDC unit heads have received more responsibility to design and implement projects and be accountable of output. Greater authority has been given to the directors of our regional offices to focus on local priorities.

New staff are being added to expand programs in molecular-based studies.

New offices were created to support the expansion of our center in the future. The Grant Development Office was created to explore new areas of funding opportunities, provide resource support to scientists for proposal preparation, and facilitate communications among scientists and donors. We also created an International Cooperation Office to strengthen linkages between AVRDC and national agriculture research and extension systems (NARES) as well as to coordinate the development of international networks.

Many young scientists have been added to our staff. These scientists bring expertise in molecular marker-assisted breeding, molecular plant pathology, interspecies allium genetics, chemical ecology in pest management, and organic vegetable production. Also, AVRDC is accelerating its Ph.D. student program in vegetable research for degree training.

Partnerships with other institutions are being expanded for new synergies and economic efficiency. For example, AVRDC is a partner in a new horticulture initiative with U.S. universities, which focuses on horticultural crops in the developing world. AVRDC is collaborating with CGIAR centers in the areas of whitefly control (with CIAT), peri-urban agriculture (with CIP), cropping systems in the Indo-Gangetic valley (with ICRISAT, CIMMYT and IRRI) and in West Africa (with WARDA), integrated pest management (with ICIPE), assisting HIV/AIDS impacted regions (with ICRAF), and developing policies related to fruits and vegetables (with IFPRI).

Strategic program direction

Four central themes have been established in our new strategic program direction:

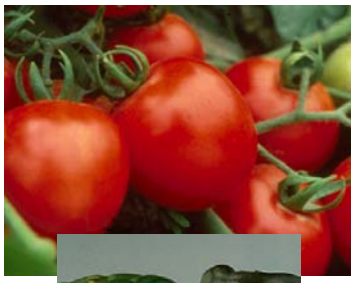
1. Innovative germplasm enhancement technologies for greater productivity, consumer acceptance, and biofortification;
2. Year-round supply of safe and nutritious vegetables;
3. Indigenous vegetables for biodiversity, healthy diet and marketing; and
4. Interactive, user-friendly information management.

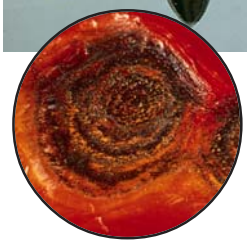
The development of productive lines is a priority of AVRDC research.

Programs will focus on major Solanaceous crops (tomato, pepper, and eggplant), bulb alliums (onion and garlic), vegetable legumes (mungbean and vegetable soybean) and indigenous vegetables (many species).

Chapter 2

Impact 2003





High quality tomatoes on virus-resistant vines

For decades, AVRDC has developed improved tomato lines that resist heat and diseases. These lines are grown on thousands of hectares in the world today. Now, AVRDC is focusing more than ever on fruit quality. In 2003, AVRDC released its highest quality fruit lines that resist multiple diseases. These fresh market and processing lines will assure growers of stable yields and success at the market.

Resistance to pepper anthracnose

Last year, breeders from the Rural Development Administration (Korea) and AVRDC released the world's first anthracnose-resistant lines, albeit wild species of pepper. But a new breakthrough occurred in 2003—anthracnose-resistant lines of cultivated pepper, *Capsicum annuum,* (see green pepper). Now it is easier for breeders to incorporate this genetic resistance into their varieties. This natural resistance will protect crops and reduce the need for fungicides in the future.

Chili peppers that tolerate flooding

Flooding during the rainy season destroys pepper crops. In a ROC Council of Agriculture (COA)-sponsored project, AVRDC identified chili peppers which tolerate flooding. These lines can be used for chili production in flood-prone areas or be used as rootstocks for sweet pepper production during the summer when market prices are highest.

Broccoli varieties for the monsoon season

Broccoli is becoming popular around the world for its flavor, potential cancer-fighting ability, and nutritional qualities. In the hot-wet season, most varieties suffer from low yields and diseases. In 2003, AVRDC scientists looked at 159 varieties collected from all over the world. Despite monsoon rains and oppressive heat, 10 varieties were identified that will reliably produce yields exceeding 10 t/ha in the summer.

Over 50,000 and counting ...

AVRDC is the home of the world's largest and most diverse collection of vegetable germplasm. In 2003 we achieved another milestone—50,000 accessions. This germplasm is an international public good that is accessible to all. Requests from universities, national government organizations, and seed companies in 71 countries were processed in 2003. This repository is a treasure chest full of genes from which we can develop varieties that are higher yielding, more nutritious, resist diseases, and protect our food security.

Protecting nature's treasures

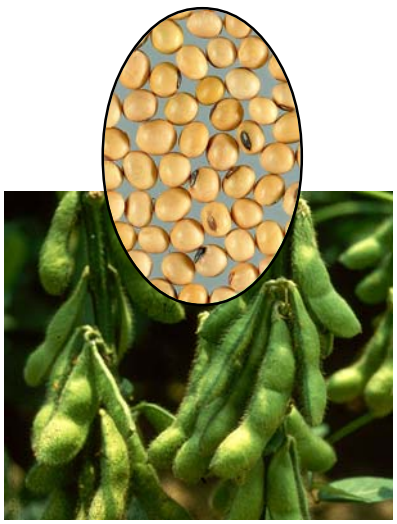
They are easy to grow, full of healthy nutrients, and create new marketing opportunities for women farmers. Once forgotten, traditional indigenous vegetables are becoming important crops in our future. In 2003, AVRDC intensified its activities in protecting these treasures, many of which are under threat of extinction. With financial support from the Asian Development Bank, training workshops were conducted in Cambodia, Lao PDR and Malaysia, followed by germplasm collecting expeditions. Scientists evaluated hundreds of selections for their usefulness in enhancing nutrition and income in the developing world. Seeds of promising lines are being multiplied for distribution.

Plants that add spice—and years—to your life

Antioxidant activity is correlated to reduced risks of cancer and age-related diseases. In 2003, AVRDC scientists conducted an exhaustive analysis of antioxidant properties for hundreds of types of vegetables. Some of the more interesting findings are that currant tomatoes, brown-fruited peppers, red cabbage, and sweet potato vines are especially high in these properties. AVRDC is developing protocols to efficiently analyze these properties in the hope of developing new varieties that will add spice and years to our lives.

Broad-based protection against tomato diseases

AVRDC is using the latest in biotechnology to develop disease-resistant tomatoes. In collaboration with National Science Council/Academia Sinica, a regulatory gene, *NPR1*, has been identified in the plant genus *Arabidopsis* that can add resistance to numerous diseases. We found that most *NPR1*-transgenic tomato plants provided enhanced resistance to a broad range of diseases, including Fusarium wilt, gray leaf spot, bacterial wilt, and bacterial spot diseases. Just as important, no deleterious side effects on plant growth were observed over three generations. These transgenic lines may be utilized in breeding for resistance to multiple diseases.



A flavor breakthrough—fragrant soybeans

Soybean is one of the most widely grown crops in the world today. This legume is also very nutritious, containing high levels of protein, iron and numerous vitamins. In spite of its nutritional value, many people in developing countries will not eat soybean due to its objectionable "beany" flavor. Recently, AVRDC and Japanese scientists have identified a vegetable soybean, Dada-cha-mame, with special fragrance similar to Basmati rice. This flavor breakthrough is expected to have immediate impact. These fragrant soybeans can generate new sources of income for poor farmers through both marketing of harvested crops as well as home-based marketing of processed products such as soymilk and sprouts. The diets of the poor may be significantly improved, especially in countries where vegetarian-based, protein-deficient diets predominate.

Pesticide-free systems for leafy vegetables

Leafy vegetables are gaining popularity, but producing them safely is getting tougher than ever. Many insecticides are becoming less useful since insect pests are developing resistance to the chemicals. In research sponsored by the development agencies of France, Germany, Taiwan and the United Kingdom, AVRDC developed systems that produce safe vegetables in net structures. This strategy, verified in tests by farmers in Cambodia, Philippines and Vietnam, produces safe vegetables with little or no pesticide use. Farmers benefit from reliable yields and consumers enjoy the assurance they are eating safe food.

Fertilizer systems that protect the environment

Intensive cultivation of leafy vegetables is a common practice in peri-urban farming areas. High levels of fertilizer are commonly used in these systems, creating risks of harmful nitrate levels in vegetables as well as pollution caused by the leaching of nitrates into water supplies. In 2003, AVRDC identified nitrogen monitoring systems that farmers can easily use in the field. These monitoring systems can help farmers produce safe vegetables, protect the environment, and maximize their profits by using fertilizers more efficiently.

New partners expand training to new countries

Private seed companies and AVRDC-Asian Regional Center worked together to provide training on seed production. For the first-time ever, ARC provided training to North Korean researchers in a project sponsored by the Swiss government. In addition, over 700 research and extension personnel were educated through a series of 18 in-country training courses conducted in Cambodia, Lao PDR, Myanmar and Vietnam. All of these training activities contribute to the empowerment of researchers, business personnel, and farmers in the region.

Maximizing production of a vital crop for Africa

African eggplant is the most important traditional vegetable in West and Central Africa. The FAO reports that improvement of this crop is vital for improving food security throughout Africa. AVRDC-Regional Center for Africa has conducted research to develop a package of recommended practices for the crop. Sweet-flavored, high yielding varieties have been identified. To date, more than 700 kg of African eggplant and other indigenous vegetable seed have been distributed.

Reaching out to West Africa

AVRDC has initiated a new network that will increase vegetable production and consumption in West Africa. Working with WARDA and with the support of COA, AVRDC has created a team of national researchers from Burkina Faso, Benin, Chad, Côte d'Ivoire, The Gambia, Mali, Senegal and Togo to work together to reduce poverty and malnutrition in the region. A baseline survey is already underway and AVRDC's improved varieties are being introduced into the region.

Chapter 3

The Mungbean Revolution in Asia

The micronutrient crisis

There is a crisis on the farms in the Indo-Gangetic Plains of South Asia. The major cropping system used by farmers in this region, rice followed by wheat, is not environmentally sustainable. Continuous cultivation of rice and wheat is resulting in deteriorating soils, declining water tables, salinization, increasing insect pest and disease populations, and other environmental problems in the region. Alternative crops, preferably soil-enriching legumes, are needed to sustain farming in the region.

There is also a crisis in the workplace, because the quality of food produced by farmers in the region is imbalanced. Rice and wheat cannot provide the micronutrients (vitamins and minerals) people require for healthy and productive lives. Over one billion persons in the region, most of them women, suffer from anemia, the most serious form of iron deficiency. Economic studies show that this micronutrient deficiency reduces household income by an average of 3.5 to 5.5%.[8]

Of even greater concern in the long-term is the crisis in the classroom. Most of the children in South Asia are anemic, significantly reducing their ability to learn. Malnourished children are more susceptible to disease and are more likely to persist in poverty in comparison to well-nourished children.

There is hope. Legumes can sustain the soils and enrich the diets of the poor. After the harvest of wheat and before the planting of rice, the land often remains fallow for 70 days. Among legumes, early maturing (60-day) mungbean varieties fit nicely into this window.

A team of scientists from six nations and AVRDC have joined efforts to expand the use of mungbeans into the region's cropping systems. Objectives of the interdisciplinary project are to develop superior varieties, establish a seed production network, develop improved production practices, and to incorporate mungbeans into the diets of the people.

Most women and children in South Asia suffer from inadequate micronutrients in their diets.

Mungbeans, a popular pulse, can sustain soils and improve diets in the region.

An international team of breeders worked together to develop superior varieties.

Teamwork in action

The researchers from Bangladesh, India, Myanmar, Nepal, Pakistan, and Sri Lanka initially met to develop the work plan of the project. They agreed that the major limitation of mungbean production in South Asia is mungbean yellow mosaic virus (MYMV).

Working in collaboration, the team of breeders discovered resistance to MYMV in a single mutated plant. The genes for MYMV-resistance from this plant were then combined with other desirable traits such as early and uniform maturity, bold seed, and high productivity. The improved germplasm was shared and varieties were released in the participating countries.

Mungbean yellow mosaic virus (right) can reduce yields by 10–85%.

To facilitate the adoption of these high yielding varieties, trials were conducted on sowing dates, seed rates, tillage requirements, fertilization, and irrigation practices. With funding support from the Department for International Development (United Kingdom), over 51,000 tons of seeds were produced by a network of public and private sector organizations in 2003.

Higher incomes, fertile soils and healthy diets

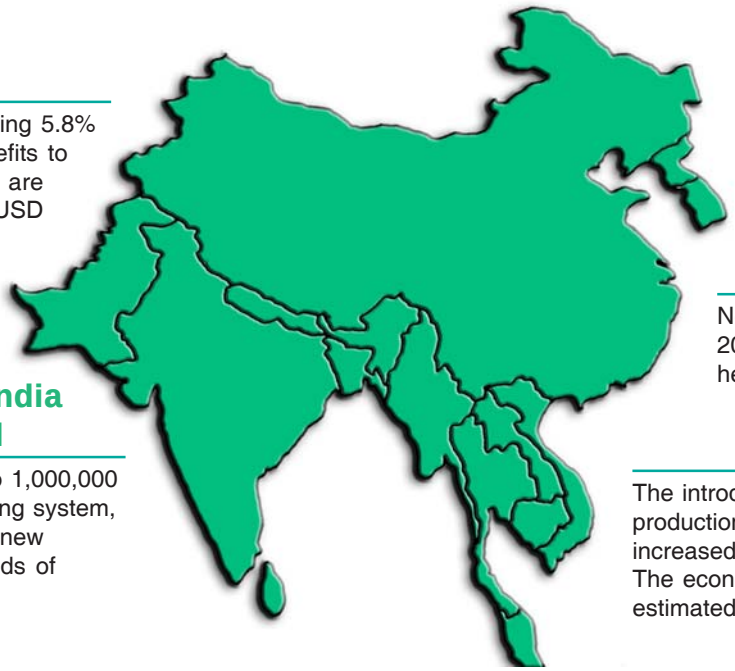
Farmers are enthusiastically accepting the new varieties. Literally millions of farmers will sow these varieties in 2004 and 2005. This success follows a similar pattern of success in Myanmar, where AVRDC varieties were introduced and are planted on 900,000 ha today. Success was likewise achieved in China, where AVRDC-enhanced varieties are planted on 800,000 ha.[9]

Pakistan

Production levels are rising 5.8% annually. Economic benefits to farmers and consumers are estimated at 25 million USD annually.

Bangladesh, India and Nepal

Mungbean will be added to 1,000,000 ha of the rice-wheat cropping system, generating 235 USD/ha of new income and increasing yields of subsequent rice crops.



China

Collaborative research has led to higher yields, more exports, and an overall benefit of 98 million USD. Over 800,000 ha will be sown in 2004.

Thailand and Cambodia

New lines were released in 2003 and thousands of new hectares will be sown in 2004.

Myanmar

The introduction of AVRDC lines increased production from 40,000 to 900,000 ha and increased yields from 307 to 720 kg/ha. The economic benefit of this research is estimated at 27 million USD annually.

The mungbean revolution has begun and is spreading throughout Asia. In recent years, millions of farmers have added early maturing mungbean into their cropping systems—and millions more farmers will do so in the future.

Economic studies in the Indo-Gangetic Plains of India show that adding mungbeans into the rice-wheat rotation is increasing farmers' net incomes by 27%. The soil-enriching effects will also lead to higher yields in the rice crops that follow the mungbean planting.[10]

The value of mungbeans as an iron source to the diets of people is substantial. Productivity enhancement of anemic female workers in Pakistan due to enhanced iron availability of improved mungbean varieties accounts for 3.1 to 4.2 million USD.[11]

Nutritional studies conducted in collaboration with Avinashilingam Institute for Home Science and Higher Education for Women showed that feeding schoolchildren with an inexpensive mungbean-vegetable dish at lunch significantly improved the levels of iron in their blood.[12] These encouraging findings can lead to a brighter future for children in South Asia.

Food scientists from local Indian universities and AVRDC have developed recipes for mungbean using affordable vegetables. When cooked with these vegetables, the bioavailability of iron in mungbean increases twofold. Books of these high-iron mungbean recipes are being published and widely distributed.

Feeding studies show that mungbean-enriched meals improve the health of schoolchildren.

Recipe books of nutritious mungbean recipes have been published and distributed.

Challenges ahead

The mungbean revolution in Asia is a remarkable success story. Our challenge now is to sustain this success and expand it to other needy areas in the world. Of immediate concern is that new strains of MYMV have emerged in India. AVRDC has identified new genes of resistance, and with additional funding, we can immediately transfer these genes into the new lines to stabilize yields.

The food crisis in Africa is worsening—hunger is increasing, farm soils are degrading, and agricultural productivity is declining. We need to introduce mungbean and other locally acceptable legumes into their cropping systems immediately. Working with WARDA, AVRDC has recently established a substation in Mali to introduce legumes and other vegetables into the rice-based systems of West Africa.

We need to get these improved varieties out to more farmers. Seed production systems need to be developed throughout Africa, as well as in the poorest nations of Asia, including Cambodia and Lao PDR. Models of success are available, including the seed village system of India, in which lead farmers are trained to produce seeds for local farmers. Partnerships among the public, private and non-profit communities have been shown to be essential in these efforts.

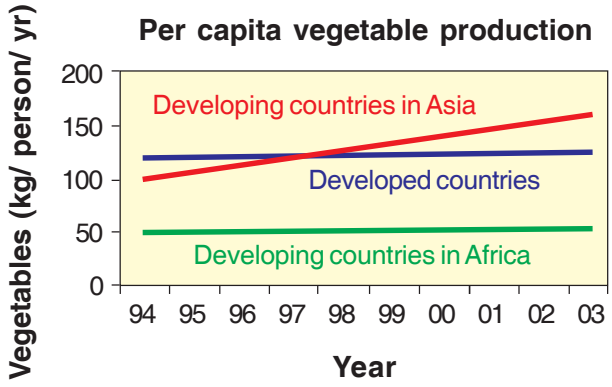
The new frontier for this work is in Africa, where legumes show great potential for improving farm productivity and nutrition.

Chapter 4

Outlook and Objectives 2004

Trends in vegetable production

Vegetable production is steadily increasing throughout the world. Since 1994, worldwide production has risen at an impressive rate of 4.97% per year.[13] However, yields per hectare have increased only slightly, 0.42% per year, indicating that production gains are largely due to bringing additional land into vegetable production. Gains have been highest in developing countries, which have seen increases in production and yields of 6.58% and 0.69% per year, respectively, over this 10-year span.



Vegetable production levels are rising to meet the needs of the growing population of Asia, but production is stagnant in Africa.

The recent growth rate for vegetable production in developing countries of Asia is particularly impressive. Over the past 10 years, vegetable production for this group of countries has risen at the rapid pace of 7.14% per year. Since 1999, the production of vegetables per capita in the developing countries of Asia has actually exceeded levels found in developed countries (see above figure).[14]

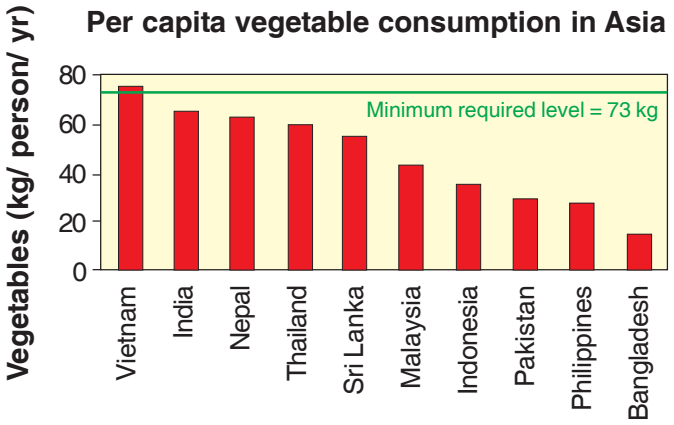
In contrast to the dynamic vegetable production sector in Asia, there has been little progress in Africa, and short-term developments are very distressing. Drought, soil degradation, underinvestment in women as agents of economic growth, and the relentless HIV/AIDS epidemic have ravaged agricultural production throughout the continent.[15]

The HIV/AIDS crisis in Africa has especially reduced productivity in vegetable cultivation, a labor-intensive enterprise. The production of vegetables per capita in most countries has actually declined since 1999.[16] The effect of HIV/AIDS on available farm labor has been so destructive that many vegetables consumed in Africa today are not *cultivated*, but rather *gathered* from uncultivated areas. These wild vegetables, including amaranth, nightshade, and jute mallow are vital for the food security of many families living in crisis.[17] At this moment, despite favorable weather in 2003, food emergencies have been declared in 24 countries of Africa and millions of persons will require food aid to survive.[18]

Looking globally, international trade is opening new markets for farmers in developing countries. However, over 95% of vegetables consumed in developing countries are produced locally.[19] The families living in developing countries will need to be empowered to feed themselves. Lack of foreign exchange in these countries will continue to limit the importation of food.

Trends in vegetable consumption

Although vegetables are essential for human health, most people in developing countries do not have affordable access to this food. In Asia, although vegetable production is increasing at a higher rate compared to other major food crops, post-harvest losses and inadequate income contribute to widespread malnutrition. Many persons in Asia, especially in South Asia, consume less than half of the vegetables they need to live a healthy life (see figure).[20]



Vegetable consumption levels are inadequate throughout much of Asia.

Malnutrition is also rampant in sub-Saharan Africa where millions of families are facing severe hunger. In fact, the majority of Africans suffer from inadequate access to food today.[21] Of even greater concern is that conditions are worsening. The International Food Policy Research Institute predicts an 18% rise in the number of malnourished children from 2001 to 2020.[22] Malnutrition is already linked to more than 50% of infant and child mortality in the region.[23]

Vitamin A deficiency (VAD), largely due to inadequate consumption of vegetables, causes tens of thousands of children to go blind each year[24] and raises each child's risk of death from infectious diseases, which are the leading causes of childhood mortality in developing countries.[25] In pregnant women, VAD causes night blindness and increases the risk of maternal mortality.

The harmful effects of vegetable-deficient diets are further compounded by the HIV/AIDS crisis. Malnutrition hastens the progression of HIV and increases transmission rates from mother to child. Mounting evidence indicates that early HIV infection is linked with dietary deficiencies of vitamin A and zinc,[26] nutrients that can be obtained from vegetables. Vitamin supplements are a short-term solution, but the World Health Organization reports that a longer lasting solution to these deficiencies, especially in rural areas of developing countries, involves vegetable gardening.[27]

Gardening is a sustainable solution to the global micronutrient crisis.

Main objectives of AVRDC

AVRDC – the World Vegetable Center is focused on increasing **productivity**. This is the first step to improving nutrition. A recent study has shown that a 1.0% increase in agricultural productivity in developing countries leads to a reduction in the malnutrition of children by at least 0.4%.[28] Increasing productivity will increase the poor's access to nutritious vegetables, which in turn will lead to healthier diets and improved worker productivity and income.

To increase yields, AVRDC is placing greater emphasis on the development of hybrid varieties. The natural boost of vigor possessed by hybrids is being used to fight the stresses of disease, heat, and drought. Impressive advances at AVRDC have been made in developing hybrid tomato and pepper lines that can match the performance of many popular varieties grown in developing countries. Protocols to assist private seed companies and NARES in producing hybrid seed are being developed and disseminated through training and on-line communications.

AVRDC is focused on improving **stability**. Disease, heat, drought, and flooding all threaten stability of vegetable supplies. In this regard, AVRDC's variety improvement programs made remarkable impact in 2003. Our interdisciplinary team of plant breeders, pathologists, and biotechnicians developed the highest quality tomato lines available that resist leaf curl geminiviruses, the major constraint of tomato production in the tropics. Another breakthrough was the discovery of the first cultivated pepper (*Capsicum annuum*) lines with resistance to anthracnose. This discovery will make it easier than ever for seed companies and NARES to incorporate this resistance into their varieties.

Our interdisciplinary, international teams are developing disease-resistant chili peppers to stabilize yields for millions of farmers.

AVRDC will share this germplasm with all nations and all seed companies. With regard to the latter, there is a dramatic increase in the use of AVRDC germplasm by private seed companies. A recent survey showed that free access to this germplasm especially benefits small and young companies. In fact, 50% of tomato varieties released by such seed companies in Asia contain AVRDC germplasm.[29] This is clear evidence that AVRDC contributes to economic growth and development in rural areas. Our partnership with the private sector will continue to grow—these alliances are critical in the fight against hunger.

AVRDC is focused on increasing **sustainability**. AVRDC has been a leader in the introduction of soybean and mungbean lines throughout the world. Soybeans are the only major staple crop that sustain both human health and the environment. Among staple crops, its dietary protein is of the highest quality and quantity. Since soybean is a legume, its roots can obtain nitrogen from the air and transfer it to the soil, thereby enriching the fertility of the land.

AVRDC's soybean germplasm is the foundation for most of the crop's production in the world.

AVRDC's soybean lines are the principal genetic material used by NARES and seed companies in breeding varieties grown by millions of farmers in the tropics and subtropics. Our lines are the only source of genetic resistance to soybean rust, one of the most severe diseases in developing countries today and a major threat to world food security.

AVRDC is focused on ensuring **food safety**. Many of today's growers are inappropriately using toxic pesticides, thereby threatening the health of themselves and consumers. In our peri-urban projects, we have seen growers spray their leafy vegetable crops the day of harvest, and sometimes even on the piles of harvested produce before it goes to market. A recent study in Bangladesh revealed that many eggplant growers spray their crops over 80 times per growing season using mixtures of non-registered pesticides.[30] This places farmers at great risk, not to mention consumers and the environment.

Accessibility to safe vegetables must be provided to all people. AVRDC is working with its partners to develop technologies that are safe for farmers, consumers, and the environment. Innovative technologies, such as insect barriers and pheromone traps, are significantly reducing—and sometimes eliminating—the need to spray insecticides on leafy vegetables, eggplant and other vegetables. Our disease-resistant cultivars are another natural means that millions of farmers use to reduce the need for applying pesticides.

The overall goal in all of our work is improving the **welfare of poor families**. For that reason, socio-economics is an integral element of all projects. This expertise is helpful to understand the needs of clients before a project begins, the effects of a project during its implementation, and finally the ultimate impacts.

AVRDC is particularly sensitive to the impacts of our technologies on **women**, who are the principal producers and marketers of most vegetable crops. AVRDC supports the empowerment of women through our educational programs and by promoting rural economies. In the 1970s, only 27% of our trainees were women—today, 50% of our trainees are women. Several of our programs, including our initiatives in Africa on indigenous vegetables and our nutritional studies in South Asia, are specifically targeted toward improving the livelihoods of women.

This simple sticky trap is one component to our eggplant IPM strategy that reduces pesticide use from 80+ sprays to nearly zero per season.

Year-round availability of safe vegetables is a priority at AVRDC – the World Vegetable Center.

The investment of education in women is critical in our shared goal of alleviating poverty and hunger in developing countries.

Chapter 5

New Initiatives 2004

AVRDC is growing—we are increasing our staff numbers, expanding our programs to new regions of the globe, and reaching out to a broader base of clientele. The following is a sampling of our new initiatives for 2004. In all cases, we invite the scientific community, NGOs, farmers' associations, donors, and other stakeholders to work with us as partners in these efforts.

Organic vegetable production

Millions of subsistence farmers do not purchase chemical inputs—these farmers could increase their crop yields if they were provided with information and training in science-based organic production techniques. An international survey recently concluded there is a lack of research in organic agriculture systems.[31]

Nearly all of AVRDC's existing technologies are compatible with organic agriculture. With this strong foundation to build upon, AVRDC has launched a new program on organic production technologies for vegetables. The Center will focus on components that solve problems specific to organic farming systems, such as sustainable soil management, disease-resistant cultivars, and biological pest control methods.

Molecular marker-assisted breeding

AVRDC is placing greater emphasis on using molecular tools in its breeding programs. Our breeders are designing molecular markers that link to genes of disease resistance. Breeders can then use these markers to accumulate these useful genes, thereby achieving disease resistance that will be stable in the field.

The usefulness of this technology was evidenced recently in southern India, where tomato leaf curl virus (ToLCV) is the greatest threat to production. In collaboration with Cornell University, our scientists used molecular-based tools to identify strains of the virus, select genes of resistance from wild tomatoes, and breed the genes into cultivated lines. After only a few years, ToLCV-resistant lines were developed that produce twice the yield of the most popular varieties in the region.

AVRDC scientists are using transgenics to solve problems that cannot be solved through conventional breeding. Preliminary studies with transgenic tomato look extremely promising. For ex-

ample, using the *NPR1* gene of the plant *Arabidopsis*, it may be possible to bring broad-based resistance to many hard-to-control diseases in tomato crops, thereby reducing the need for pesticides. AVRDC will continue this work in a responsible manner. We will limit our transgenic work to either closely related species or already approved and released trans-genes, and will follow the highest standards of safety and regulation before considering the release of products.

Health-promoting properties in vegetables

Many vegetables are rich in antioxidants, which are reported to reduce risks of certain cancers and age-related diseases. AVRDC scientists are analyzing the antioxidant properties of the most diverse collection of vegetables in the world. Lycopene, beta-carotene, phenols and other functional properties are being measured. We have already identified superior species and varieties of vegetables to focus our future research upon. We are also developing protocols to efficiently analyze for functional properties in the hope of developing new varieties that will add years to all of our lives.

Cucurbit breeding

Cucurbits include a variety of high value crops (e.g., cucumbers, melons, gourds and squashes) that play important roles both in local diets and as cash crops in developing countries. Shared interests among AVRDC and selected universities, IARCs, NARES, and the private seed sector have recently created new opportunities for collaborative research in cucurbit breeding.

A major limitation to production of cucurbits worldwide is infection by viruses, many of which can reduce yields by 50–100%. AVRDC will work with its partners to develop virus resistance in cucurbits, using a combination of molecular genetics and conventional breeding approaches. Another research thrust will be expanding the evaluation of our collection of indigenous cucurbits for potential utilization. AVRDC will also conduct expeditions in Central and Southeast Asia, where many cucurbits originate, to find new sources of desirable genes for breeding purposes.

Central Asia Vegetable Network

Families living in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) are among the poorest in the world. Vegetables are grown by small-scale farmers (mostly women) around their households and sold in local markets. The region is the center of origin of many vegetables (for example, onion, spinach, carrots and melons) and opportunities for germplasm collection and improvement are vast. Unfortunately, support for vegetable research is limited.

In 2003, AVRDC brought scientists from this region together for the first time since their countries became independent. A network is being established to assist these scientists in working together to attain food security, poverty alleviation, and sustainable agriculture in their region.

Chapter 6

Budget Highlights 2003–06

Financial results for 2003

The total revenues for 2003 were 10.013 million USD, of which 54% were core funds and 46% special project funds. The total expenditures for 2003 were 9.497 million USD, resulting in a positive balance of 0.516 million USD from core funds. There was a negative translation adjustment in an amount of 0.352 million USD, resulting from unfavorable exchange rate of USD and NTD against Euro during 2003; however, with the additional year-end balance of 0.386 million USD carried over from 2002, a total carryover balance of 0.550 million USD was left at the end of 2003.

The total revenues for 2003 were increased by 10%, compared to the Board-approved figure of 9.092 million USD. This increase in core and special project funds was made mainly by ROC. The increased contributions from ROC included 0.118 million USD for core funds, 0.368 million USD for balancing the predicted deficit due to an increase in local staff personnel costs and general operation costs, and 0.244 million USD for collaborative research projects.

Strong donor support was obtained for our initiatives that promote vegetables as sources of income for women.

In 2003, ROC contributed 77% of the total core funds and 27% of total special project funds, amounting to 54% of the total revenues. Substantial levels of core funding were also provided by the United States, France, Thailand, Japan and the Philippines. Germany contributed 32% of the total project funds (15% of total revenues), making them the second largest donor overall to the Center. Other major sponsors of special projects included the Asian Development Bank (ADB), International Plant Genetics Research Institute, and development agencies from the United Kingdom, Switzerland, United States, Australia, Japan and Korea. Seconded scientists were provided by France, Japan and Korea.

The total expenditures of 9.497 million USD were 0.341 million USD less than the Board-approved figure of 9.838 million USD. This is attributable to the postponement of filling some IRS positions and the delay in submitting expense

Statement of financial position, 2003 (000 USD)

Assets	
Current assets	7,121
Properties/equipment	51
Total	**7,172**
Liabilities and Net Assets	
Current liabilities	2,820
Net assets	3,756
Translation adjustment	596
Total	**7,172**

liquidation statements for contracted outreach research. The outstanding advance of 0.565 million USD will be liquidated in 2004.

Total personnel costs for internationally recruited staff (IRS) and nationally recruited staff (NRS) were 5.172 million USD, which is 55% of the total expenditures. This is 5% higher than the Board-approved figure of 50%. The slight increase in the personnel costs was mainly due to the adjustment of living costs, promotion within the same salary grade, and through upgrading.

In conclusion, the total revenues for 2003 were 10.013 million USD, while the total expenditures were 9.497 million USD. A decrease in expenditures plus an additional 2002 year-end carryover of 0.386 million USD resulted in a positive balance of 0.550 million USD left at the end of 2003.

Financial outlook for 2004

The total revenues in 2004 will be increased by around 8%, to 10.891 million USD. Of the total revenues, 5.578 million USD will be core funds (51%) and 5.313 million USD (49%) special project funds. Expenditures will be 11.441 million USD, which is around 0.550 million USD over the expected revenues. Since a positive balance of 0.550 million USD will be carried over from 2003, the final budget will be balanced.

AVRDC's safe vegetable programs have generated new core support from donors.

The ROC is expected to increase their core contribution to 4.235 million USD from 4.152 million USD of 2003, a 2% increase in value. An amount of 3.903 million USD, equivalent to 129 million NTD, core contribution from ROC has been confirmed. It is expected that ROC will support the remaining 0.332 million USD equivalent to 11 million NTD, to offset a 3.9% increase in personnel and operational costs and a reduced amount (0.170 million USD) resulting from the expected 20% reduction in the special project funding from ROC/Council of Agriculture (COA) compared to the previous year. The ROC/COA and Ministry of Foreign Affairs (MOFA) have made a special project contribution in an amount of 1.011 million USD to help improve part of the Center's equipment and aged facilities.

The United Kingdom is a new core donor. The Department for International Development of the United Kingdom will donate 0.3 million Pound Sterling per annum, equivalent to 0.54 million USD, as unrestricted core funds for 2004 and 2005. The core contribution from Japan in 2004 is expected to be 0.096 million USD, which is same as 2003. There are indications that the Center may receive a core contribution from the USA for 2004.

Future budget allocation and staffing

The total personnel costs of IRS and NRS will be 50% of the total expenditures and it is less than that of 2003. However, the actual amount spent on personnel will increase from 1.852 million USD in 2003 to 2.245 million USD in 2004 mainly due to the increase in IRS positions from 19 to 24.

The budget allocation for contracted outreach research for collaborative activities will be increased by 117% to 1.411 million USD from 0.651 million USD of 2003. This increase is attributable mainly to the outstanding advance of 0.565 million USD in 2003, which is to be liquidated in 2004.

Positions to be added in 2004 include Central Asia network program coordinator, IPM development consultant, and post-doctoral fellows in entomology, molecular plant pathology, molecular marker development, and organic agriculture. Seconded/sabbatical staff to be assigned in 2004 include a legume breeder, allium embryologist and a biotechnology specialist.

Recent advances in our onion breeding research have generated new opportunities for expansion of this program.

The total revenues are projected to be 12.338 million USD and 12.647 million USD for 2005 and 2006, respectively, which are about 8% and 3% increases in value compared to 2004 and 2005, respectively.

The actual personnel costs will increase in 2005 and 2006 mainly due to the addition of more IRS positions, including an onion breeder, indigenous leafy vegetable specialist and ICRISAT/AVRDC collaborative research specialist, to strengthen the research capacity. However, the total personnel costs of IRS and NRS will remain around 50% of the total expenditures.

An amount of 1.011 million USD granted by ROC/COA and MOFA in 2004 will complete only about 30% of total required renovation of the Center's equipment and facilities. To complete all required renovation and construction, an additional amount of 2.4 million USD will be needed, which will be equally allocated for use in 2005 and 2006. The Center will make a special request for 1.2 million USD per annum to ROC/COA & MOFA in 2005 and 2006 for renovations and to present a proposal for a new laboratory building.

Closing comments

The financial plan for 2004–2006 is based on cost efficiency. It is expected that ROC will continue making major core contribution and additional special project grants will be received from ADB and development agencies of Germany, Japan, UK, France, Switzerland and USA.

Budget projection by objects, 2004–2006 (USD 000)

Object Expenditures	2004 Proposal	2005 Projection	2006 Projection
Personnel			
IRS	2,245	2,492	2,567
NRS	3,450	3,667	3,776
Operations			
Field labor	708	729	758
Supplies	913	1,000	1,000
Travel	272	300	330
Training and workshops	543	600	665
General expenses	888	950	950
Contract outreach research	1,411	1,400	1,400
Equipment and facilities	1,011	1,200	1,200
Total	**11,441**	**12,338**	**12,647**

Annex 1

Milestones Achieved 2003

For more information on these research accomplishments, please refer to *AVRDC Progress Report 2003.*

Theme 1. Genetic improvement

1 Detecting and transferring important traits from wild species and other sources

- High levels of lycopene, vitamin C, phenolics and soluble solids were detected in *L. pimpinellifolium*.
- AFLP was used to develop molecular markers for pepper anthracnose resistance genes derived from *Capsicum chinense*.
- Two hundred F_1 recombinant inbred lines were screened for bruchid resistance gene through bulked segregant analysis with RAPD. Three potential RAPD markers were identified.
- Two distinct tomato-infecting geminiviruses in Vietnam have been identified, cloned and sequenced. Specific primers for the detection of these viruses have been developed.
- Three tomato and six chili geminiviruses from Pakistan were cloned and sequenced. One of each of the tomato and chili viruses was a new distinct virus bringing the total to four distinct chili and two distinct tomato viruses in Pakistan, all of which have been identified by AVRDC.
- IC-RT-PCR was set up for ChiVMV detection using a newly developed primer pair CVMV1037/CHOIR that amplifies 536 bp in the CP region. This primer pair was also able to detect ChiVMV in samples from Thailand and Indonesia.
- Tomatoes transformed with CMV coat protein gene were evaluated for their potential of weediness—data indicated the chance was minimal. This is the first biosafety assessment conducted for transgenic vegetable in Taiwan.
- An evaluation routine was designed for disease screening of transgenic tomato over-expressing *NPR1* and/or *ScaM4.* A total of 60 R0, R1, R2 lines were evaluated for bacterial spot and bacterial wilt resistance. Two superior lines were characterized for resistance mechanism to bacterial wilt.

2 High yielding, disease-resistant tomatoes, peppers, vegetable legumes, onions and crucifers

- Disease resistance genes, *ap*1 and *hrap*, which were cloned from tomato and pepper, respectively, were transformed into tomato through *Agrobacterium*. The T_1 transgenic tomatoes demonstrated resistance against the infection of bacterial wilt.
- Disease resistance gene, *VrCRP*, a defense related gene cloned from AVRDC's improved mungbean line, was transferred to tomato and the T_1 transgenic tomatoes were able to defend themselves against the infection of gray leaf spot.
- Four heat-tolerant, geminivirus- and bacterial wilt-resistant tomato hybrids (TLCV15, TLCV32, FMTT847, PT4727) were selected and seed increased for international distribution.
- Four heat-tolerant, geminivirus- and bacterial wilt-resistant tomato inbreds (CLN2545, CLN2498, CLN2123, CLN2116) were selected and seed increased for international distribution.

- Specific primers for new tomato geminiviruses from Taiwan, Philippines, and Vietnam were developed.
- FLA456 was identified as stable source of geminivirus resistance in El Salvador and Mexico as part of a joint project with CIAT.
- A formal transfer on pathogen typing methods from USDA was established.
- Mapping population for anthracnose resistance was grown out in F_2 generation and phenotyped, tissues were harvested and submitted for AFLP analysis, superior individuals were selected and advanced to F_4 generation, and backcrosses initiated.
- Agronomic trials of early-maturing mungbean varieties were conducted using SML 668 (selection from NM 94), Pusa Vishal (selection from NM 92) and UPM98 (VC6368[46-40-4]); these lines fit well in the rice-wheat cropping system of the Indo-Gangetic plains.
- The barrier between direct crossing of blackgram and mungbean is being overcome. F_1 seeds were obtained from VMC02003 (VC6372 × GBno.2) and VMC02005 (NM 92 × GBno.5). Seeds were advanced to F_2 generation.
- Promising yellow and red onion bulb lines were identified in storage testing.
- A green garlic variety trial was conducted at AVRDC and two other locations. Lines were identified that produced 16–44% higher yields compared to commercial checks.
- Thirty shallot lines were tested—the highest yielding line was 170% better than the standard check.
- Different pathogenicities of Fusarium isolates were found comparing onion seedling vs. bulb tissues.
- A total of 159 accessions of broccoli were evaluated for early maturity, heat tolerance, disease resistance, productivity, and quality traits during hot-wet summer conditions. Ten superior lines were selected for further testing.

3 Tomato, pepper, and vegetable legume lines with improved health promoting properties

- High beta-carotene cherry tomato CHT1200 was released in Taiwan as Hualien-AVRDC No. 13.
- The use of *hp* and *dg* genes was determined to be the best means to increase lycopene content in large-fruited tomato.
- Ample genetic variation for individual and total antioxidant activities was found in *Capsicum annuum*. Brown-fruited peppers produced significantly higher contents of carotenoids and beta-tocopherol compared to red peppers.
- A screening tool for single seed evaluation of methionine content was developed.
- Mungbean recipes of higher iron bioavailability were developed for northern India and published.
- Isoflavone patterns were determined for four vegetable soybean varieties at R5.5, R6, R7 and R8 for two seasons; higher isoflavone density was obtained in autumn and the highest found in AGS292 both at R6 and R8 stages.

4 Increased capacity of partners to conduct genetic improvement and seed production

- Researchers from seed companies in Bhutan (2 persons) and Hong Kong (1), and NARES in India (2), Ethiopia (1) and South Korea (1) received training in conventional plant breeding techniques. Numerous undergraduates from the Philippines and Taiwan were trained in related applications.
- Research interns from Korea (4 persons), Vietnam (1) and Thailand (1), and students from Taiwan (5) and the Philippines (2) received training in molecular genetics.
- A graduate student from Germany surveyed farmers and consumers for their reactions to genetically modified organisms. A research intern from Indonesia studied screening methods of viruses.
- In collaboration with The Institute of Vegetables and Flowers, CAAS, Chinese researchers were trained on AVRDC screening protocols for tomato late blight.

Theme 2. Safe, year-round vegetable supplies

1 Good agriculture practices (GAPs) for year-round vegetable production

- A simple, rapid, non-destructive in situ diagnostic method for identifying nitrate status in plant sap was established for five leafy vegetables. Relationships among crop yield, N applications, N leaching, nitrate content in leaf sap, and leaf chlorophyll content readings were quantified for these same vegetables.
- Eighty chili pepper lines with potential for use as rootstock materials were screened under field conditions for flooding tolerance; 54 lines were evaluated for resistance to bacterial wilt. Superior lines were selected and will be tested in combination with preferred sweet pepper scions in 2004.
- Grafted tomato combinations were tested under rain shelter treatments during the hot-wet season. ToLCV-resistant scions grafted onto eggplant EG203 rootstock produced the highest yields.
- Balanced organic/inorganic fertilization practices (liquid nutrient solutions combined with organic or inorganic fertilizer) were tested for sweet pepper, chili pepper and fresh market tomato.
- AVRDC participated in a GTZ-sponsored IFOAM study to identify research needs in organic vegetable production.

2 Integrated pest and disease management technologies

- Molecular tools for detecting bacterial wilt were revised, reducing the number of required samples from 20 to 10 per 0.1 ha.
- A robust protocol was developed for production of safer leafy vegetables under nethouses and temporary net tunnels.
- *Diadegma semiclausum*, a parasitoid of DBM, was introduced in highlands of Kenya and Tanzania via ICIPE. Results show that DBM damage and pesticide use is significantly reduced.
- An IPM strategy was developed in studies on the control of eggplant fruit and shoot borer (EFSB) in South Asia. A package of IPM practices was implemented on farmers' fields in pilot project studies in Bangladesh and India. Socio-economic parameters of pesticide misuse were characterized.

3 Partnerships to promote vegetable production technologies and consumption

- A contract with the Asia & Pacific Seed Association (13 companies) was awarded to develop a marker linked to the *Ty-2* geminivirus resistance gene.
- The 2003 Annual Meeting of the CGIAR System Wide Program on IPM (sp-IPM) was conducted at AVRDC-HQ from 3–5 March.

4 Increased capacity of partners

- Students from Taiwan (6 students), Japan (1) and the Philippines (1) were trained in crop and pest management practices. Research interns from India (3) and Cambodia (2) and Korea (1) also received training.
- Farmer groups in Taiwan were trained on new tomato and pepper technologies, grafting tomato, and safe leafy vegetable production in nethouses.

5 Information database

- A technical bulletin on IPM management of EFSB, and brochures on the production of safe leafy vegetables and the identification of insects in eggplant crops were published.

6 Better understanding on the socio-economic aspects of year-round vegetable supply

- A socio-economic study on pest control of eggplant in Bangladesh was published.

Theme 3. Indigenous vegetables

1 Collection, characterization and conservation of indigenous vegetable genetic resources

- GRSU: 3888 accessions in 32 genera and 42 species from 30 countries (includes major vegetable crops) were collected. TPSU: 31 aquatic plants (19 genera), 9 woody plants (8 genera), 23 climbers (11 genera), and 81 others (60 genera) were collected, mainly from Taiwan.
- Expeditions in four provinces of northern and central Lao PDR generated 230 accessions of at least 37 species from 65 sites and 50 farmers. Expeditions were also conducted in regions of Malaysia.
- GRSU: 387 accessions of 67 species were characterized. TPSU: 246 accessions from 169 species of 120 genera were tested in the observation plot; the facility was improved for aquatic plants with a water recycling system.
- *Momordica* spp. and *Solanum* spp. were analyzed for genetic diversity with RAPD.
- A total of 335 accessions of 30 species were regenerated.
- A total of 2779 accessions were transferred to AVRDC under RETA 5839 and conserved in medium-term storage.

2 Procurement, generation and integration of requisite information

- Names and uses of indigenous vegetables of South and Southeast Asia were updated to include Khmer names.
- Nine species were selected as promising for young shoots/leaves: *Adansonia digitata*, *Asystasia gangetica*, *Eryngium foetidum*, *Limnophila rugosa*, *Nasturtium officinale*, *Neptunia oleracea*, *Oenanthe javanica, Sauropus androgynus*, *Tetragonia tetragonioides*; one species was selected for its flower buds: *Sesbania grandiflora.*
- High antioxidant (AO) compounds were identified for Chinese cedar in collaboration with Rutgers University.
- Ten major vegetable groups from 120 species were categorized based on their AO capacities. An additional 73 species were evaluated for nutrition quality (Ca, Fe, and vitamins A, C and E), eating quality (dry matter, sugar, fiber), and antioxidant capacity in free radical scavenging.

3 Knowledge-based production and utilization technologies

- International Cooperators' Guides were published on cultural practices for *Basella*, jute mallow, kangkong, *Moringa*, and vegetable amaranth.
- A total of 113 recipes using 17 species were developed by the AVRDC staff, and faculty and students of Tainan Woman's College of Arts & Technology.

4 Partnership for promotion of indigenous vegetables and increased capacity of partners

- A total of 7913 samples were sent to 68 countries.
- In-country training on indigenous vegetable (IV) germplasm management was held in Cambodia, Lao PDR and Malaysia.
- A planning meeting for ADB RETA 6067 "Promoting Utilization of IV for Improved Nutrition of Resource-Poor Households in Asia" was held in February at AVRDC. Thirty-four individuals from ADB, AVRDC, Bangladesh, Cambodia, Indonesia, Lao PDR, Malaysia, Philippines, Thailand, and Vietnam participated.
- A training module for collecting, conservation and management of IV germplasm was developed.
- Eleven summer students from Taiwan and three from the Philippines were trained in germplasm conservation and IV production practices.

Theme 4. Information technologies

1 On-line dissemination of genetic resources (germplasm) and related information

- AVRDC Vegetable Genetic Resources Information System (AVGRIS) based on Microsoft Access was developed.

2 On-line dissemination of good agricultural practices (GAP) for major vegetable crops

- AVRDC established a "virtual library" consisting of all Center publications released since 1997. This includes Annual Reports, books, bulletins, production guides, and over 100 fact sheets. Every month, approximately 10,000 persons from 120+ countries downloaded this information freely and instantly over the internet.
- Six International Cooperators' Guides on suggested cultural practices for various vegetable crops were written; production guides for 19 vegetables are now on-line.
- Production guides on grafting and using rain shelters for tomato in the hot-wet season were written and placed on-line. Brochures on growing safe leafy vegetables in net shelters and identifying insects in eggplant fields were written and placed on-line.
- Manuals on producing seed of vegetable crops and growing gardens in Asia were placed on-line.

3 On-line sharing of information on food science studies related to vegetables

- Mungbean recipe books, one originating from North India and the other South India, were placed on-line.
- A publication on increasing consumption of micronutrients through promotion of indigenous vegetables was edited and placed on-line.

4 On-line sharing of socio-economic impacts and related studies

- Publications on the impact of mungbean research in China, the health effects of supplementing diets of Indian children with mungbean meals, and the socio-economic effects of an IPM strategy for eggplant production in Bangladesh were written and placed on-line.
- Previously published works that were placed on-line in 2003 included studies of mungbean production in Pakistan, peri-urban systems in Manila, the frozen soybean industry in Taiwan, and effects of vegetable production in the highlands of Malaysia.

5 Distance training using CD-ROM, video, and internet technology

- Approximately 6000 persons accessed the tutorials available in the AVRDC Learning Center.

6 Enhanced AVRDC on-line library services

- Internet access to electronic journals was streamlined.
- Listings of pertinent literature were regularly disseminated to AVRDC staff and 350 scientists from 36 countries via e-mail.

7 Dynamic and interactive website

- AVRDC's web site was transferred to a new server in the USA, significantly increasing the speed of downloading. Added features included a simpler web address, a vastly improved search engine, enhanced the navigation components, more information, and streamlined access to electronic journals.
- Approximately 15,000–20,000 web pages from our web site are requested every month.

Asian Regional Center

1 Year-round supply of safe vegetables in SE Asia

- A simple technical guide on raised bed culture was developed.
- Purple blotch disease and high seed moisture in wet season were identified as key factors limiting seed storage of vegetable soybean.
- A protocol to control southern blight was tested using fungicide spray at transplanting and solarization of soil by transparent film.

2 User-friendly database of indigenous vegetables in Mekong Region

- Data on 5,361 accessions of 26 vegetables were provided to TVRC for database development.

3 Interactive, user-friendly information management for vegetables in the tropics

- A total of 15,153 users accessed the site from August to November. The web site is updated every 3 months.
- A database was created consisting of variety releases generated from ARC's collaboration with China, Vietnam, TVRC, and ARC (mungbean).
- A Regional Training Course alumni directory for 1982–2000 was published.
- Ten RTC research reports, a socio-economic survey report on vegetables in Mekong Region, proceedings of a mungbean conference in China, proceedings of an off-season vegetable production conference at Institute of Agricultural Science of South Vietnam, and two books in Vietnamese were published.

4 Human resource development for vegetable research, extension and adoption to farmers

- Fifteen trainees (six female) graduated from the 21st Regional Training Course (RTC) (November 2002 to April 2003). Sixteen trainees (four female) are attending the 22nd RTC (November 2003 to April 2004).
- Sixteen trainees (three from private sector) attended a seed production course.
- Seventeen trainees from private sector attended the International Seed Testing Association-sponsored seed test training course.
- Workshops were conducted in Myanmar (25 participants), northern Vietnam (RIFAV) (70), and central Vietnam (HUFA) (33)—a total of 128 participants.

Regional Center for Africa

1 Germplasm management and promotion of African indigenous and priority exotic vegetables

- A total of 180 accessions of 9 African indigenous vegetable (AIV) species were collected.
- Six AIV species (amaranth, spider plant, vegetable cowpea, African eggplant, nightshade, and jute mallow) were evaluated for productivity and quality traits.
- Twenty lines of Ethiopian mustard, 33 lines of African eggplant, 55 lines of amaranth, 21 lines of nightshade, 9 lines of jute mallow, and 19 lines of spider plant were purified and selected for quality and productivity.
- Four late blight-resistant tomato lines were made available for multi-location trials.
- Improved production practices for spider plant, jute mallow, nightshade, okra, amaranth, African eggplant and Ethiopian mustard are being developed.
- Utilization methods for spider plant, jute mallow, pumpkin, amaranth, nightshade, African eggplant, and Ethiopian mustard are partially developed.

2 Sustainable seed supply systems for AIV's and priority exotic vegetables

- Seed production protocols of spider plant, Ethiopian mustard, and jute mallow were partially developed.
- Base seed of amaranth, Ethiopian mustard, spider plant, African eggplant, and jute mallow were made available for distribution.

3 Strengthening the capacity of researchers and extensionists of national systems

- A total of 24 participants from 20 African countries were trained in "Vegetable Crops Production and Research" from July–November 2003.
- One MSc student and four undergraduate research interns were trained.
- One PhD student is being trained.
- A review and planning workshop on "Vegetable Research and Development in Malawi" was conducted in September.
- Seeds and information leaflets were distributed to over 200 farmers who attended the RCA field day in October.

Annex 2

Milestones Ahead 2004–06

Theme 1. Genetic improvement

1 Transferring important traits from wild species and other sources to broaden the genetic base

- Advanced backcross QTL populations are evaluated for important tomato traits.
- Anthracnose resistance genes are mapped and characterized.
- Mapping populations for resistance to mungbean bruchid and MYMV are characterized and mapping is conducted.
- Mapping of H7996 bacterial wilt resistance and new ToLCV resistance from *L. chilense* and *L. hirsutum* is conducted.
- Marker-assisted selection for root knot nematode and ToLCV is integrated into breeding activities.
- Additional molecular markers linked to important tomato traits, e.g. BW, ToLCV, heat tolerance, CMV, etc. are identified.
- Selection procedures for disease resistance in tomato transgenic lines are developed and field testing is conducted.
- ToLCV gene constructs are developed. Transgenic tomato carrying ToLCV and CMV constructs are tested for resistance.

2 Tropically adapted tomatoes, peppers, vegetable legumes, onions and crucifers

- A heat-tolerant tomato strategy is developed to increase heat tolerance levels.
- Factors shaping BW strain populations in tomato are determined.
- Promising tomato lines with broad-based BW and TYLCV resistance are tested in multilocation trials.
- The importance of TSWV/WSMV in targeted areas of tomato production is determined.
- New sources of resistance to ToLCV are identified, especially for the Americas and Africa.
- Screening protocols for tospoviruses are developed and hot spots identified.
- Lines with multiple late blight genes and multiple disease resistance are evaluated internationally.
- Sweet pepper lines resistant to anthracnose and bacterial spot are developed.
- Heat-tolerant sweet pepper lines with resistance to 2–3 targeted diseases are developed.
- A pepper leafcurl virus testing network is initiated.
- The interaction of available resistance sources with strains of major pathogens (CMV, ChiVMV, BW, anthracnose) from major chili production areas of Asia are elucidated.
- Technology is developed to overcome the barrier of interspecific direct crosses between blackgram and mungbean.
- Farmers in South Asia begin producing and marketing vegetable soybeans.
- The molecular diversity, the role of seeds in transmission, and the epidemiology of MYMV in major Asian food legumes are understood.

- Biochemical factors characterized and traits of bruchid resistance in blackgram (VM2164) are identified.
- Promising fragrant vegetable soybean lines are identified and then evaluated in selected countries.
- Improved mungbeans are extended to at least one million hectares in South Asia.
- An impact assessment survey among mungbean farmers is conducted in at least two Asian countries.
- A baseline survey on potential for vegetable soybean is conducted in at least two Asian and two African countries.
- Five onion lines with 20 t/ha yield are tested by NARES under short-day, cool-dry conditions.
- The heritability of Stemphylium leaf blight resistance in *A. fistulosum* is known.
- Crucifer accessions are screened for priority traits and crosses are made between trait donors and targeted crucifer crop classes.
- New crucifer accessions with resistance to TuMV are identified, advanced populations evaluated, and resistance to the disease in tropical Chinese cabbage becomes understood.

3 Tomato, pepper, and vegetable legume lines with improved health promoting properties

- High beta-carotene tomato and sweet pepper lines are evaluated internationally.
- *Capsicum*, *Lycopersicon* and *Solanum* accessions with high carotenoid and/or high antioxidant activities are identified and crossed with elite lines.
- The genetics of antioxidant activity of selected accessions are determined.
- Screening, selection and multi-location testing of mungbean lines high in methionine and iron are conducted.
- Promising lines of legumes with high isoflavone and tocopherol contents are selected.
- The stability of isoflavones and tocopherol content in different locations and seasons is studied.

4 Better knowledge on the vegetable seed sector

- An updated analysis of the utilization of AVRDC enhanced lines and total number of releases of major vegetable crops by the private sector is completed.
- A seed sector assessment study in the Greater Mekong subregion is conducted.

Theme 2. Safe, year-round vegetable supplies

1 Good agriculture practices (GAPs) for year-round vegetable production

- A production package is developed using chili pepper rootstocks in off-season sweet pepper production.
- Low-cost micro-irrigation systems are evaluated and adapted to target sites in Asia and Africa.
- An organic research program is established at AVRDC HQ; field research commences.

2 Integrated pest and disease management technologies

- Detection and diagnosis techniques are refined for field samples of bacterial wilt (BW), other soil-borne pathogens, and tomato leaf curl virus (ToLCV). Baseline surveys and epidemiologies are conducted.
- IPM models of BW, ToLCV and late blight are tested at strategic locations in Asia.
- An IPM package consisting of biopesticide and sex pheromone against armyworm is developed.
- The impact of TuMV on major crucifers in tropical lowlands is assessed.
- IPM packages for Chinese cabbage and other selected crucifers are developed.
- An IPM package to control eggplant fruit and shoot borer is extended throughout much of South Asia.
- Component control methods are developed against eggplant fruit and shoot borer, bean pod borer, bruchids, and striped flea beetle, based on host specificity.
- Diamondback moth parasitoids become established within selected sites in highlands of Africa and Central America. High temperature-tolerant types are introduced into lowlands of Africa and Asia.

3 Increased capacity of partners

- Comprehensive books on vegetable pest and disease management are published and the AVRDC production training manual is revised.

4 Information database

- An expert system for fertilization and composting practices is developed.

5 Better understanding on the socio-economic aspects of year-round vegetable supply

- A study on global demand and supply of vegetables is completed.
- An assessment of the role of vegetable production for commercialization of the agricultural sector is conducted in Bangladesh.
- Studies on marketing and export opportunities for vegetables are conducted for three sites in Asia.
- Demand elasticity analyses are conducted for Vietnam, Indonesia, and China.
- A cost-benefit analysis of food-based approaches to combat micronutrient malnutrition is conducted.
- A study on the role of vegetables for diversification of agriculture in South Asia is conducted.
- Demand analysis for organic vegetable products is conducted at two pilot sites.
- A study on the economics of vegetable production under nethouses is conducted for one site.
- The profitability of vegetable production in peri-urban systems is analyzed in Hanoi. The seasonality of vegetable prices is analyzed for Phnom Penh and Vientiane.
- The interface of peri-urban vegetable production, water, and health issues is assessed for a selected site in Asia and Africa.
- Post-harvest production surveys are conducted in four Asian countries.

Theme 3. Indigenous vegetables

1 Collection, characterization and conservation of indigenous vegetable genetic resources

- A total of 150 new species are morphologically characterized, ambiguous species molecularly described, descriptors for new species developed, and basic information collated.
- A total of 1500 newly acquired accessions are regenerated for conservation, purified, multiplied for trials, and preserved ex-situ.

2 Procurement, generation and integration of requisite information

- A database consisting of information collected on genetic resources, botany, agro-ecology, horticulture, seed production, nutraceuticals, postharvest handling, and uses, is established and updated regularly.
- Species/types that thrive under the hot-wet environment, require less inputs, and are palatable identified.
- Yield trials of potential species/types conducted, and promising species/types that are less dependent on agrochemicals yet still can achieve high yields are identified.
- Seed production technologies of promising species/types are developed, and seeds multiplied.
- Farmer-participated multilocation testing of promising species/types is conducted.
- Micronutrient densities, antioxidant capacities, and toxicants of selected species are determined.
- Promising species/types for value-added products are analyzed and selected.
- A NIRS6500 spectrum library is developed using 1500 samples (60+ species) from several locations.

3 Knowledge-based production and utilization technologies

- Household culinary techniques that both improve the nutritional/functional value of promising species/types and reduce demands on homemakers' time are developed.
- Cultural practices that maximize cropping diversity and/or yields, and minimize inputs are developed for homes, schools and farms.
- Extension materials on the production of indigenous vegetables are prepared.
- Attainable yield and potential dietary intakes of vitamin A from beta-carotene-rich vegetables, and iron from iron-rich vegetables are determined.
- Nutrition kits consisting of seeds, processed vegetables, and vegetable extracts are designed for targeted users such as women and children in Southeast Asia and/or HIV/AIDS afflicted communities in Africa.

4 Socio-economic assessments for market growth and crop diversification

- An assessment of knowledge and consumption levels of indigenous vegetables (IVs) is completed in Malawi, Tanzania, Uganda, and Rwanda.
- The role of schoolgardens for enhanced knowledge and consumption of IVs is assessed in at least three Asian countries.
- A profitability analysis of major IVs is conducted in at least three Asian countries.
- An econometric model for hedonic demand analysis for indigenous vegetables is developed.
- A consumers' survey on factors that influence their demand for vegetables is conducted.
- Recommendations for selection criteria for IVs based on consumer preference are developed.

5 Partnership for promotion of indigenous vegetables and increased capacity of partners

- Twenty researchers from Asia and Africa are trained annually.

Theme 4. Information technologies

1 On-line dissemination of genetic resources (germplasm) and related information

- The AVRDC Vegetable Genetic Information System (AVGRIS) is migrated onto a new platform to enhance compatibility and efficiency with external users.
- The AVRDC genebank database is integrated into SINGER (CGIAR System-wide Information Network for Genetic Resources).
- An on-line seed catalog is launched on the AVRDC web site. Seeds of tomato, sweet and chili pepper, mungbean, vegetable soybean, and promising indigenous vegetable lines are available to partners.

2 On-line dissemination of good agriculture practices (GAP) for major vegetable crops

- GAPs suggested for 20 crops, published in English, are placed on-line.
- GAPs for priority crops are translated into Mandarin, Vietnamese, French, and Spanish; then published and placed on-line.
- Regular news updates are disseminated via e-mail to interested stakeholders.

3 On-line sharing of information on food science studies related to vegetables

- A database of available information on nutritional composition and functional properties for over 200 vegetables is compiled.
- Recipes for mungbean dishes that enhance bio-availability of iron, and recipes for 40+ Asian vegetables are placed on-line.

4 Distance training using CD-ROM, video, and internet technology

- Informational materials, such as Annual Reports, tutorials, and International Cooperators' Guides and Fact Sheets are available on CD-ROM.
- An on-line course on vegetable IPM is conducted.

5 Enhanced AVRDC on-line library services

- Minisis Web Interface (MWI), SDI literature, CD-ROM and E-journal databases are established to provide online access to Tropical Vegetable Information System (TVIS) databases.
- The number of users of library services via internet increases by an average of 50% per year.
- On-line searching systems of CD-ROM and E-journal databases are integrated.
- The Windows NT server is upgraded to Windows XP in order to facilitate the speed on MWI.
- Data in AVRDC card catalogs are placed on-line.

6 Dynamic and interactive web site

- An on-line bookstore is launched to facilitate sales of books, seeds, and miscellaneous merchandise.
- The tomato, indigenous vegetable, and nutrition databases are migrated onto new platforms to enhance compatibility and efficiency with external users.
- The number of persons downloading information from the AVRDC web site increases by 50% per year, amounting to an average of 50,000 users per year.
- Major components of the web site are translated into Mandarin, Spanish and French.
- Sixty AVRDC books/bulletins in web-searchable and downloadable formats are placed on-line.
- An AVRDC on-line photo library consisting of 1000 images is established and placed on-line.

Asian Regional Center

1 Productive, disease/pest resistant, and locally adapted mungbean varieties

- Seed of 2–3 superior mungbean lines is produced for on-farm testing.

2 Year-round supply of safe vegetables in SE Asia

- Improved cropping systems are developed for raised bed culture in the tropical lowlands, sandy soil and hot-dry conditions in Central Vietnam, and upland areas in the Mekong Region.
- Simple methods for storing soybeans are developed through research and on-farm demonstration.
- IPM strategies to combat southern blight and anthracnose on pepper, bean pod borer on yardlong bean, and flea beetles on leafy crucifers are developed in collaboration with NARES.

3 User-friendly database of indigenous vegetables in Mekong Region

- Data on 100–150 crops/types of indigenous vegetables from the Mekong Region are stored in AVRDC database after characterization, evaluation and documentation in collaboration with TVRC.

4 Interactive, user-friendly information management for vegetables in the tropics

- A total of 6000 persons access the AVRDC-ARC regional web site and 2000 documents from the site are downloaded per year.
- A garlic variety and production database is developed.
- A mungbean research database is developed.
- ARC-RTC technical reports are published on-line.
- Three production guide books and one major AVRDC publication are translated into Lao, Khmer and Vietnamese through collaboration with NARES.
- An extensive list of technical terms in vegetable production and research is translated into Vietnamese, Lao and Khmer through collaboration with NARES.

5 Human resource development for vegetable research, extension and adoption to farmers

- Twenty NARES staff are trained annually through our regional training course (RTC) on vegetable production and seed cultivation.
- Ten senior extension staff and five researchers are trained annually in RTC research and extension courses.
- A total of 300 local extension staff and 350 lead farmers in Mekong Region are trained annually in collaboration with NARES. At least 80% of these trainees subsequently organize trainings or consult with other farmers who are interested in growing vegetables.

Regional Center for Africa

1 *Germplasm management and promotion of African indigenous and priority exotic vegetables*

- A total of 200 accessions of African indigenous vegetables (AIV) are collected from highland and lowland areas and conserved ex-situ. Among these accessions, 150 are characterized and multiplied.
- Data on AIV germplasm is integrated into AVRDC's database on indigenous vegetables.
- Promising AIV accessions are evaluated for horticultural characters through multilocation trials.
- Seeds of promising AIV accessions are purified and multiplied for distribution.
- Two to three promising late blight-resistant tomato lines are characterized, evaluated for horticultural characters, and made available to NARES.
- One to two promising lines of vegetable soybean, mungbean and pepper are identified and made available to NARES.
- Base seed of promising lines of priority exotic vegetables are multiplied and distributed.
- Improved horticultural practices for 5–7 AIV and priority exotic vegetables are developed, published and disseminated to research partners and lead farmers.
- Recipes for 2–3 priority AIVs are developed, tested, and published.

2 *Sustainable seed supply for AIVs and priority exotic vegetables*

- Methods for seed production, processing, and storage for 6 AIV and exotic crops are developed.
- Breeder/base seed of 1–2 AIV lines is produced and available for distribution.

3 *Strengthening the capacity of researchers and extensionists*

- A total of 15–20 NARES, NGO or private sector personnel (40–50% women) are trained each year in our 4-month regional training course on vegetable cultivation and seed production.
- A total of 15–20 NARES, NGO or private sector personnel (40–50% women) are trained each year through in-country training courses.
- A total of 15–20 persons are trained on cultivation and utilization of African indigenous vegetables each year through a special skills course.
- A total of 15–20 persons are trained on vegetable seed production and marketing each year through a special skills course.
- Two to three undergraduate/graduate research interns are trained annually.
- Training modules are updated regularly.
- National priority setting workshops on vegetable research are conducted in one sub-Saharan country per year, in collaboration with major partners.
- At least one field day is conducted each year at AVRDC-RCA to demonstrate recommended production practices and to distribute improved seeds.

Annex 3

Budget Information 2003–06

Revenue and budget tables	*Page*

Table 1. Summary financial statement, 2003 (USD 000)

	Core		Project		Total		Budget (Board Approved)	
Revenues								
Grant	4,745		4,612		9,356		8,720	
Other revenues and support	657		0		657		372	
Total revenues	**5,402**	**54%**	**4,612**	**46%**	**10,013**	**100%**	**9,092**	
Expenditures								
Object Expenditures								
Personnel								
IRS	1,153		700		1,852	20%	1,812	18%
NRS	2,747		573		3,319	35%	3,150	32%
Operating expenses								
Field labor	461		244		705	7%	691	7%
Supplies	185		748		933	10%	869	9%
Travel	56		164		219	2%	298	3%
Training and workshop	18		748		766	8%	587	6%
General expenses	267		538		805	8%	941	10%
Contract outreach research	0		651		651	7%	1,287	13%
Equipment, facilities & renovations	0		247		247	3%	203	2%
Total	**4,886**		**4,612**		**9,497**	**100%**	**9,838**	**100%**
Strategic Themes								
1. Genetic improvement	936		1,063		2,000	21%	2,272	23%
2. Safe, year-round vegetables	893		1,164		2,057	22%	2,409	24%
3. Indigenous vegetables	359		1,354		1,713	18%	1,287	13%
4. Information dissemination	623		667		1,289	14%	1,263	13%
Administration and Services	2,075		363		2,438	26%	2,607	26%
Total expenses	**4,886**	**51%**	**4,612**	**49%**	**9,497**	**100%**	**9,838**	**100%**
Revenues less expenses	516		0		516		(746)	
Translation adjustment	(352)				(352)			
Changes in net assets	164				164			
Net assets beginning of the year	386		0		386		386	
Net assets at the end of the year[1]	**550**		**0**		**550**		**(360)**	

[1] Excludes working capital fund of $900,000 as end of 2003.

Table 2. Breakdown of revenues, 2003 and 2004 (USD 000)

	2004 Proposed		2003 Actual		2003 (Board Approved)	
Core funds						
ROC	4,235		4,152		4,034	
United States	0		200		200	
Japan	96		96		96	
Korea	75		0		75	
Thailand	101		110		101	
Philippines	50		39		50	
France	76		147		147	
UK/DFID	540		0		0	
Other revenues (see below)	405		657		372	
Subtotal	**5,578**	**51%**	**5,401**	**54%**	**5,075**	**56%**
Project funds[1]						
ACIAR	12		86		69	
Asian Development Bank	548		354		520	
APSA	20		0		0	
France	212		123		180	
Farm Africa	54		0		0	
Germany/BMZ/GTZ	1,363		1,475		1,490	
IPGRI	0		40		0	
Japan	62		83		62	
JIRCAS	200		0		0	
Korea/RDA	20		53		40	
ROC/COA & MOFA	1,011		368		0	
ROC/COA & NSC	723		893		649	
Swiss/SDC	399		256		496	
UK/DFID	352		315		281	
USAID	337		200		200	
USDA	0		40		30	
Training and other	0		326		0	
Subtotal	**5,313**	**(49%)**	**4,612**	**46%**	**4,017**	**44%**
Contribution in-kind[2]						
France	(2)		(1)		(1)	
Japan	(1)		(1)		(1)	
Korea	(1)		(1)		(1)	
Total revenues	**10,891**	**100%**	**10,013**	**100%**	**9,092**	**100%**
Other						
Revenue on project support			532			
Interest earned			73			
Miscellaneous income			10			
Refund on previous payment			9			
Technical service			3			
Training overhead			30			
Total			**657**			

[1]The grants are recognized as revenue based on the expenses actually incurred. Excess of grants received over expenses, representing grants applicable to succeeding year is classified as accounts payable.
[2]Number of outposted scientists (in kind).

Table 3. Statement of financial position, 2003 (USD)

		Totals
Current Assets		
Cash		4,962,370
Petty cash		2,545
Deposit paid		29
Accounts Receivable		822,568
Employees	19,645	
Regional centers	802,923	
Advance payment		1,324,506
Contract outreach research	565,339	
Donor project	751,805	
Prepaid expenses	7,362	
Inventories		8,524
Fixed Assets		51,104
Equipment and furniture	72,024	
Less accumulated depreciation	(20,920)	
Total Assets		**7,171,645**
Current Liabilities		
Accounts payable		2,819,571
Grant received in advance	2,450,664	
Accrued expenses	368,907	
Total Liabilities		**2,819,571**
Net Assets (assets less liabilities and translation adjustment)		3,756,014
Operation fund	549,771	
Working capital fund	900,000	
Appropriated fund	2,306,243	
Total Net Assets		3,756,014
Translation Adjustment		596,060
Total Liabilities and Net Assets		**7,171,645**

Table 4. Budget allocations by strategic themes and services, 2004 (USD 000)

	Proposal 2004						2003	
	Core		Special		Total		Actual	
Revenues								
Grants	5,173		5,313		10,486		9,356	
Other revenues and support	405				405		657	
Total	**5,578**	**(51%)**	**5,313**	**(49%)**	**10,891**	**(100%)**	**10,013**	
Budget Allocation[1]								
Strategic themes								
1. Genetic improvement	1,117		1,515		2,632	(23%)	2,000	(21%)
2. Safe, year-round vegetable supplies	1,475		1,107		2,582	(23%)	2,057	(22%)
3. Indigenous vegetables	210		1,090		1,300	(11%)	1,713	(18%)
4. Information technologies	636		678		1,314	(11%)	1,289	(14%)
Administration and Services	2,690		923		3,613	(32%)[2]	2,438	(26%)
Total	**6,128**		**5,313**		**11,441**	**(100%)**	**9,497**	**(100%)**
Balance	(550)		0		(550)		516	
Translation Adjustment							(352)	
Changes in Net Assets							164	
Balance, Beginning of Year	550		0		550		386	
Balance, End of Year	0		0		0		550	

[1]The regional center budgets are within the strategic themes. The budget estimates for ARC and RCA 763,000 USD and 710,000 USD, respectively.

[2]Increased due to the increased investment in facility and equipment renovation.

Table 5. Budget projection by objects, 2004–2006 (USD 000)

Object Expenditures	2004 Proposal	2005 Projection	2006 Projection
Personnel			
IRS	2,245	2,492[1]	2,567
NRS	3,450	3,667	3,776
Operations			
Field labor	708	729	758
Supplies	913	1,000	1,000
Travel	272	300	330
Training and workshop	543	600	665
General expenses	888	950	950
Contract outreach research	1,411	1,400	1,400
Equipment and facilities	1,011	1,200	1,200
Total	**11,441**	**12,338**	**12,647**

[1]Areas of focus will include onion breeding, indigenous/leafy vegetable production, and ICRISAT/AVRDC collaborative research.

Table 6. Budget projection by strategic themes and services, 2004–2006 (USD 000)

Themes/Services	2004 Proposal	2005 Projection	2006 Projection
Strategic Themes			
1. Genetic improvement	2,632	2,900	3,000
2. Safe, year-round vegetable supplies	2,582	2,800	2,900
3. Indigenous vegetables	1,300	1,483	1,520
4. Information technologies	1,314	1,474	1,497
Administration and Services	3,613	3,700	3,750
Total	**11,441**	**12,357**	**12,667**

Table 7. Proposed staff composition, 2004–2006

Staff Category	2003 Actual	2004 Proposed	2005 Proposed	2006 Proposed
Internationally recruited staff (IRS)	19	26	27	27
Seconded/sabbatical staff	4	5	5	5
Post-doctoral fellow	0	4	4	4
Consultant staff (with a duration of more than 6 months)	6	7	7	7
Nationally recruited staff (NRS)	177	178	180	180

Annex 4

Special Projects 2004

Theme 1. Genetic improvement

Control of geminivirus diseases of cotton and tomato in Australia and Pakistan. Australian Centre for International Agricultural Research (ACIAR). S.K. Green. 01 January 2001–31December 2004. A$2,260,110.

Development of a PCR-based screening protocol for detection of a gene conditioning geminivirus tolerance in tomato. Asia & Pacific Seed Association (APSA). E. Graham. 28 November 2003–29 November 2007. US$60,000.

Arabidopsis-Rs functional genomic. National Science Council (NSC)/Academia Sinica. J.F. Wang. 01 January 2004–31 December 2004. NT$300,000.

Characterization of transgenic tomato conferring broad-spectrum disease-resistance and a preliminary study of defense mechanism. NSC/Academia Sinica, J.F. Wang. 01 January 2004–31 December 2004. NT$950,000.

Genetic transformation, insecticidal activity and bioinsecticide development of bruchid resistant protein VrCRP of mungbean. NSC. C.A. Liu. 01 August 2003–31 July 2004. NT$1,301,500.

Development of locally-adapted, multiple-disease-resistant, high-yielding chili (*Capsicum annuum*) cultivars for targeted countries in Asia GTZ. S.K. Green. 01 March 2002–28 February 2005. Euro 1,350,000.

Application of molecular markers to broaden the genetic base of tomato for improved tropical adaptation and durable disease resistance. GTZ. P. Hanson. 01 March 2004–28 February 2007. Euro 1,200,000.

Improving income and nutrition by incorporating mungbean in cereal fallows in the Indo-Gangetic Plains of South Asia. Department for International Development (DFID). S. Shanmugasundaram. 01 March 2002–31 March 2004. UK£300,000.

Development of technologies for the improvement of vegetable cultivars for the subtropical and temperate areas. RDA Rural Development Administration, Korea (RDA, Korea). L. Engle. 01 January 2004–31 December 2005. US$60,000.

RDA seconded scientist. RDA. P.D. Ham. 01 August 2002–31 July 2004. US$40,000.

Improving the research facilities of AVRDC - The World Vegetable Center. ROC Ministry of Foreign Affairs. G. Kuo. NT$34,000,000.

Theme 2. Safe, year-round vegetable supplies

Monitoring *Phytophthora infestans* in Taiwan for population shifts that may affect late blight management strategies. ROC Council of Agriculture (COA). T.C. Wang. 01 January 2004–31 December 2004. NT$1,583,000.

On-farm evaluation, monitoring of population dynamics, and control measures for tomato late blight and tomato leaf curl virus in Taiwan. COA .T.C. Wang. 01 January 2004–31 December 2004. NT$500,000.

Use of ecological information on the development of integrated management system for tomato bacterial wilt. COA. J.F. Wang. January 2004–31 December 2004. NT$500,000.

Implementation and promotion of an integrated pest management strategy for the control of eggplant fruit and shoot borer (*Leucinodes orbonalis*) in Indo-Gangetic Plains of South Asia. DFID. N.S. Talekar. 01 October 2003–30 September 2005. UK£300,000.

Impact of heavy metals on sustainability of fertilization and waste recycling in peri-urban and intensive agriculture in Southeast Asia. ACIAR. M. Palada. 01 July 2001–30 June 2005. A$238,864.

Economic analysis of the peri-urban vegetable systems. U.S. Department of Agriculture. M. Ali. 01 April 2001–31 July 2004. US$75,000.

Improved sustainability of smallholder peri-urban vegetable production in South Asia. European Union. P. Hanson. 01 January 2003–31 December 2005. Euro 22,223.

Impact of modern vegetable technologies on the development of agribusiness in Bangladesh. K. Weinberger. 01 September 2003–29 February 2004. Euro 20,000.

Theme 3. Indigenous vegetables

Promoting the utilization of indigenous vegetables for improved nutrition of resource poor households in Asia. Asian Development Bank (ADB). L.M. Engle. 01 January 2003–31 December 2005. US$1,000,000.

Domestication of selected African indigenous vegetables in Tanzania - an ex-ante impact assessment. GTZ. K. Weinberger. 01 June 2003–31 May 2004. Euro 62,000.

Theme 4. Information technologies

Improved access to information on the genebank collections of the Asian Vegetable Research and Development Center through the System-wide Information Network for Genetic Resources (SINGER). International Seed Federation. L. Engle. 01 July 2003–31 December 2004. US$47,500.

Outreach stations

Collaborative vegetable research network for Cambodia, Lao People's Democratic Republic and Vietnam, Phase I. ADB. M. Suzuki. 01 March 2002–31 March 2005. US$650,000.

AVRDC-ARC human resource development project for Mekong Region, Phase IV. Swiss Agency for Development and Cooperation (SDC). M. Suzuki. 01 April 2003–31 March 2007. US$1,601,000.

Peri-urban agriculture sustainable development for food security in Southeast Asia (Vietnam, Laos, Cambodia) French Ministry of Foreign Affairs. M. Ali. 01 January 2002 – 31 December 2004. Euro 425,857.

Germplasm collection, evaluation and improvement of African leafy vegetables. U.S. Agency for International Development (USAID). M.L. Chadha. M.L. Chadha. 01 May 2002–31 Mary 2006. US$103,500.

Promotion of neglected indigenous vegetable crops for nutritional health in Eastern and Southern Africa. M.L. Chadha. M.L. Chadha. 01 March 2004 – 28 February 2006. Euro 1,270,000.

AVRDC technical support on conservation and regional characterization of African leafy vegetables. International Plant Genetic Resources Institute. M.L. Chadha. 06 November 2003–31 March 2004. US$30,000.

Empowering small scale and women farmers through sustainable production, seed supply and marketing of African indigenous vegetables in East Africa. Farm Africa, Maendeleo Agricultural Technology Transfer Fund. M.L. Chadha. 01 February 2004–31 January 2006. UK£60,000.

Collaboration with WARDA on promotion of superior vegetable cultivars. COA. G. Kuo. 01 January 2002– 31 December 2004. US$60,000.

Annex 5

Future project ideas

AVRDC is expanding our efforts to meet the needs of the poor in the developing world. The following is a sampling of project ideas that require donors, and in some cases, additional partners:

Theme 1. Genetic improvement

- Development of molecular markers for mungbean yellow mosaic virus resistance
- Genetic improvement of tomato and pepper for increased content of vitamin A and antioxidants
- Technical assistance on the characterization of *Phytophthora infestans* and the development of disease management of tomato late blight in China
- Utilization of *Allium roylei* as a bridge species between *A. cepa* and *A. fistulosum* to facilitate introgression of resistance to Stemphylium leaf blight into cultivated onion
- Polyploidization of interspecific onion progenies, followed by 'haploidizing' ovule culture to seek true breeding stable recombinants that combine bulbing capability, seed productivity, and resistance to Stemphylium leaf blight
- Development of temperature stable cytoplasmic male sterile sweet pepper line pairs
- Comparison of characterization data of AVRDC's *Capsicum* germplasm collection and that of the USDA's *Capsicum* PI collection
- Combination in *C. annuum* of genes for resistance to anthracnose (*Colletotrichum* spp.) derived from *C. chinense* and from *C. baccatum*
- Introduction of Bt-crystal protein genes derived insect resistance in yardlong bean and mungbean for the control of bean pod borer
- Cucurbit breeding with emphasis on breeding for lines that are rich in beta-carotene (squash) and resistant to viruses (all cucurbits).

Theme 2. Safe, year-round vegetable supplies

- Analysis of trends, constraints and potential for organic vegetable production and marketing as an alternative for improving rural income and livelihood in Southeast Asia
- Enhancing water use efficiency of vegetable production in dry areas
- Economic and nutritional security through the development of vegetable soybean-based industry in South Asia
- Alleviating iron and vitamin A deficiency through an integrated approach of production and utilization of high beta-carotene tomato and iron-rich mungbean in South Asia
- Poverty alleviation and rural development through introduction of improved vegetable and pulses and empowering the farmers to become entrepreneurs in Bangladesh

- Income generation and crop diversification by introducing improved mungbeans in cereal-based cropping systems in India, Nepal and Bangladesh
- Water requirements and timing for economic vegetable production in marginal areas in Asia
- Development of component technologies for small-scale organic vegetable producers in Asia and Africa
- Development of IPM strategy for the management of armyworm species on vegetables in Southeast Asia
- Promotion and monitoring of safer vegetable production in peri-urban area of key cities in Mekong Region
- Evaluation of induced resistance in vegetable crops to control diseases and pests as an alternative control method to chemicals in Africa
- Studying the comparative advantage of vegetables in different Southeast Asian countries to promote regional trade
- Quantifying the role of vegetables in sustainable growth in selected South, Southeast, and East Asian countries

Theme 3. Indigenous vegetables

- Enhancing indigenous vegetable marketing for local and supermarket outlets in Africa by promotion of improved post-harvest handling, processing, and utilization practices
- Poverty alleviation and income generation through the development of *Moringa*-based industries in South Asia and sub-Saharan Africa
- International symposium on production and utilization of *Moringa*
- Supporting HIV/AIDS-afflicted communities of Eastern Africa through a food-based approach: micronutrient fortification of indigenous vegetables
- Promoting development and commercialization of underutilized vegetables

Theme 4. Information technologies

- Human capacity building for national vegetable research: accelerated PhD student training program in key areas of vegetable research for war-affected countries
- Vegetable research and development training—an engine for economic and rural development in less developed countries in Asia
- Virtual World Vegetable Center—long distance education programs

Outreach stations

- The Central Asia Vegetable Research Network: connecting Central Asia's research efforts to build economic opportunities and fight poverty
- Development and promotion of vegetable home garden systems to improve livelihoods of resource-poor communities and to reduce malnutrition and HIV/AIDS in Africa
- Development of indigenous vegetable seed production systems and genetic enhancement for Africa

Annex 6

Acronyms

AARNET	ASEAN-AVRDC Regional Network on Vegetable R&D
ACIAR	Australian Centre for International Agricultural Research
AFLP	amplified fragment length polymorphism
AIV	African indigenous vegetables
APSA	Asia & Pacific Seed Association
ARC	Asian Regional Center (regional center of AVRDC)
ASEAN	Association of Southeast Asia Nations
AVGRIS	AVRDC Vegetable Genetic Resources Information System
AVRDC	Asian Vegetable Research and Development Center
BMZ/GTZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung/ Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
BW	bacterial wilt
CAAS	Chinese Academy of Agricultural Sciences
CGIAR	Consultative Group on International Agricultural Research
ChiVMV	chili veinal mosaic virus
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CLVNET	Cambodia, Laos, Vietnam Network
CMV	cucumber mosaic virus
COA	Council of Agriculture, Republic of China
CONVERDS	Collaborative Network for Vegetable Research in Southern Africa
CVMV	chili veinal mottle virus
DBM	diamondback moth
DFID	Department for International Development, United Kingdom
EFSB	eggplant fruit and shoot borer
FAO	Food and Agriculture Organization of the United Nations
GAP	good agriculture practices
GHARDEN	Global Horticulture and Rural Development Enterprise
GRSU	Genetic Resources and Seed Unit (AVRDC)
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HQ	headquarters
HUFA	Hue University of Forestry and Agriculture
ICIPE	International Centre of Insect Physiology and Ecology
ICRAF	International Council for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFOAM	International Federation of Organic Agriculture Movements
IFPRI	International Food Policy Research Institute
IPGRI	International Plant Genetic Resources Institute
IPM	integrated pest management
IRRI	International Rice Research Institute
IRS	internationally recruited scientist
IV	indigenous vegetable
MOFA	Ministry of Foreign Affairs
MWI	Minisis web interface
MYMV	mungbean yellow mosaic virus
NARES	national agricultural research and extension systems
NGO	non-governmental organization
NIRS	near infrared spectroscopy
NRS	national recruited staff
NSC	National Science Council, Republic of China
NTD	Taiwan new dollars
QTL	quantitative trait loci
R&D	research and development
RAPD	random amplified polymorphic DNA
RCA	Regional Center for Africa (regional center of AVRDC)
RDA	Rural Development Administration, Korea

RETA	Regional technical assistance
RIFAV	Research Institute of Fruit and Vegetable
ROC	Republic of China
RTC	regional training course
SAVERNET	South Asia Vegetable Research Network
SDC	Swiss Agency for Development and Cooperation
SDI	Selective Dissemination of Information
SINGER	CGIAR System-wide Information Network for Genetic Resources
Sp-IPM	Systemwide Program on Integrated Pest Management
ToLCV	tomato leaf curl virus
TPSU	Technology Promotion and Services Unit (AVRDC)
TSWV	tomato spotted wilt virus
TuMV	turnip mosaic virus
TVIS	Tropical Vegetable Information System
TVRC	Tropical Vegetable Research Centre
UNICEF	United Nations Children's Fund
UPM	Universiti Pertanian Malaysia
USA	United States of America
USAID	United States Agency for International Development
USD	United States dollars
USDA	United States Department of Agriculture
VAD	Vitamin A deficiency
WARDA	West Africa Rice Development Association
WSMV	watermelon silver mottle tospovirus

References

[1]USDA. 1996. The food guide pyramid. Center for Nutrition Policy and Promotion. Home and Garden Bulletin No. 252. Washington, D.C., USA.

[2]Hadad, L., H. Alderman, S. Appleton, L. Song, and Y. Yohannes. 2002. Reducing child undernutrition. How far does income growth takes us? International Food Policy Research Institute (IFPRI), Food Consumption and Nutrition Division, Washington, D.C., USA.

[3]Gardner, G. and B. Halweil. 2000. Underfed and overfed: the global epidemic of malnutrition. Worldwatch paper 150. Worldwatch Institute. Washington, D.C., USA.

[4]Ali, M., U. Farooq and Y.Y. Shih. 2002. Vegetable research and development in the ASEAN region: a guideline for setting priorities. *In:* C.G. Kuo (ed). Perspectives of ASEAN Cooperation in Vegetable Research and Development. AVRDC, Shanhua, Taiwan. p. 20–64.

[5]de Bon, H. and K.T. Tran. 2001. The response of peri-urban agriculture to urbanization in Vietnam. FAO Paper No. EC600E.

[6]Ali, M., U. Farooq and Y.Y. Shih. *ibid.*

[7]Weinberger, K. 2002. Survey of vegetable and non-vegetable farmers. Unpublished report.

[8]AVRDC. 2002. AVRDC Report 2001. Methodologies for impact assessment in vegetable and mungbean research. p. 59–60.

[9]Zhang, H., N. Li, X. Cheng, and K. Weinberger. 2003. The impact of mungbean research in China. Shanhua, Taiwan: AVRDC—The World Vegetable Center, AVRDC Publication No. 03-550, Working Paper No. 14. 26 pp.

[10]AVRDC. 2004. AVRDC Report 2003. Assessment of nutritional impact of mungbean research. p. 123–128.

[11]AVRDC. 2004. *ibid.*

[12]Vijayalakshmi, P., S. Amirthaveni, R.P. Devadas, K. Weinberger, S.C.S. Tsou, and S. Shanmugasundaram. 2003. Enhanced bioavailability of iron from mungbeans and its effects on health of schoolchildren. Shanhua, Taiwan: AVRDC—the World Vegetable Center, Technical Bulletin No. 30, AVRDC Publication 03-559. 32 pp.

[13]FAO (Food and Agriculture Organization of the United Nations). 2004. FAOSTAT data, 2004.

[14]FAO. *ibid.*

[15]Nathan Associates. 2003. RCSA food security strategic option: synthesis and analysis of selected readings. Submitted to United States Agency for International Development.

[16]FAO. *ibid.*

[17]Aphane, J., M.L. Chadha, and M.O. Oluoch. 2003. Increasing the consumption of micronutrient-rich foods through production and promotion of indigenous foods. FAO-AVRDC International Workshop Proceedings, 5–8 March 2002, Arusha, Tanzania. AVRDC—the World Vegetable Center, Shanhua, Taiwan. AVRDC Publication No. 03-561. 77 pp.

[18]FAO (Food and Agriculture Organization of the United Nations). 2004. Better harvests improve sub-Saharan Africa's food supply. <http://www.fao.org/newsroom/en/news/2004/40269/index.html>.

[19]Rabobank. As cited in: R.L. Cook. 1998. International trends in the fresh fruit and vegetable sector. Department of Agricultural and Resource Economics, UC Davis.

[20]Ali, M. 2001. Mega factors affecting the demand for vegetables, commodity choice, and international vegetable research. Proceedings of AVRDC 2001 Internal Review and Planning Workshop. 4–6 Dec. 2001. Asian Vegetable Research and Development Center. Shanhua, Tainan, Taiwan.

[21]Conway, G. and G. Toenniessen. 2003. Science for African Food Security. Science 299:1187–1188.

[22]IFPRI (International Food Policy Research Institute). 2001. Empowering women to achieve food security: vision 2020. Focus No. 6. IFPRI. Washington, D.C.

[23]FAO/ILSI (Food and Agriculture Organization of the United Nations/International Life Sciences Institute). 1997. Preventing micronutrient malnutrition: a guide to food-based approaches. Why policy makers should give priority to food-based strategies. ILSI Press. Washington, D.C. 11 pp.

[24]United Nations. 2000. Nutrition throughout the life cycle. Fourth report on the world nutrition situation. United Nations Administrative Committee on Coordination/Sub-Committee on Nutrition.

[25]FAO/ILSI. *ibid.*

[26]Keane, L.G., M.K. Ntiru, and B.D. Giyose. 2001. Nutrition Briefs: Linking Multiple Sectors for Effective Planning and Programming. USAID SARA, SANA Project Report.

[27]World Health Organization. 2003. Micronutrient deficiencies: Combating vitamin A deficiency. <http://www.who.int/nut/vad.htm.>

[28]Thirtle, C., X. Irz, L. Lin, V. McKenzie-Hill, and S. Wiggins. 2000. Relationship between changes in agricultural productivity and the incidence of poverty in developing countries. DFID Report No. 7946.

[29]AVRDC. 2003. AVRDC Report 2002. The growing partnership between AVRDC and private seed industry. AVRDC Publication Number 03-563. Shanhua, Taiwan: AVRDC – the World Vegetable Center. p. 36–38.

[30]Rashid, M.A., S.N. Alam, F.M.A. Rouf, and N.S. Talekar. 2003. Socio-economic parameters of eggplant pest control in Jessore District of Bangladesh. Shanhua, Taiwan: AVRDC – the World Vegetable Center. AVRDC Publication No. 03-556. 29 pp.

[31]Stoll, G. 2003. Background study on the current state of organic agriculture research in horticulture and its perspectives in Asia. Report for BMZ/GTZ, AVRDC and IFOAM.

AVRDC at a Glance

AVRDC – the World Vegetable Center is a not-for-profit international agricultural research institute run by a management team that reports to a Board of Directors whose members come from various countries.

Annual budget: Approximately US$10 million, from donors such as the ADB, Australia, France, Germany, Japan, Korea, Philippines, Republic of China, Switzerland, Thailand, United Kingdom, and United States.

Staff: Approximately 24 internationally recruited professional staff, and 180 locally recruited researchers, technical and administrative staff.

Principal partners: National agricultural research and extension systems, non-government organizations, and the private seed sector in developing countries.

Improved technologies: AVRDC's vegetable lines and complementary production technologies are improving diets and incomes in over 80 countries.

Training: AVRDC conducts training in a broad range of subject areas, including crop improvement, plant protection and biotechnology applications at its headquarters and outreach sites.

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