

Vegetables

Research and Development in the 1990s

A Strategic Plan



The Asian Vegetable Research and Development Center (AVRDC) is an international not-for-profit institute for vegetable research, development and training.

Its goal is to enhance the nutritional well-being and raise the incomes of poor people in the rural and urban areas of developing countries through improved methods of vegetable production, marketing and distribution, which take into account the need to preserve the quality of the environment.

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Contents

Foreword 5

Chapter 1

Introduction 8

Chapter 2

The Challenge 9

- The importance of vegetables 9
- Economic value 9
- Constraints to increased vegetable production 13
- The role of an international research center 13
- The need for a global effort 15

Chapter 3

A Vision of the Future 16

Chapter 4

The Asian Vegetable Research and Development Center 18

- Facilities, staffing and operation 18
- Achievements 19
- Mission 20
- Main activities 20
- Values 21

Chapter 5

Strategic Choices 23

- Which regions? 23
- Which agroecological zones? 26
- Which production systems? 27
- Which vegetables? 28

Chapter 6

Program Strategies 36

- Research 36
- Information services 43
- Training 44
- Collaborative research, technology transfer and
Institution building 46
- Monitoring AVRDC's achievements 50

Chapter 7

Implementation 53

- Organization 53
- Collaboration with other institutions 56

Chapter 8

Resource Implications 58

- Senior staff and operating requirements 58
- Capital costs 59
- Sources of funding 61

Foreword

Increased production and improved handling of vegetables have great potential to enhance the nutrition of the rural and urban poor in the developing countries, as well as to increase their incomes and provide greater opportunities for employment. Unfortunately, the national institutions charged with the responsibility for vegetables have, for the most part, only limited capacity to solve the problems and accelerate progress. Consequently, there is tremendous scope for international collaboration to meet these needs for vegetables in ways that have already proved successful with the cereals and other staple food crops.

Since its establishment in 1971, AVRDC has been active in Asia, particularly in Southeast Asia, yet the demand for collaborative activities from other regions is equally strong. The Center considers it opportune to build upon its experience in Asia and to move beyond its immediate vicinity to be of greater service to the world at large.

As an institution, AVRDC is guided and fortified by a set of implicit, but all-pervasive values, including an apolitical philosophy; the pursuit of excellence in all of its activities; a sense of equal partnership with national institutions; a recognition of the role of women in development; an acute sense of stewardship and accountability; the conviction that technological change is a primary vehicle for progress, and that the changes it engenders must be both equitable and sustainable.

In its long-term plan, the Center has made the following strategic choices: in regional coverage, AVRDC will continue to serve Asia as first priority, but will gradually expand its collaboration with countries in sub-Saharan Africa (second priority), Latin America and the Caribbean (third priority), and West Asia and North Africa (fourth priority).

Among agroecological zones, AVRDC will give first priority to the lowland humid and subhumid tropics and second priority to tropical highlands. Regional programs will exploit opportunities for spillover effects from work at headquarters and will tailor germplasm and technology to the needs of specific agroecological zones and production systems in their regions.

Among production systems, AVRDC will accord first priority to small-scale commercial production and second priority to home gardens. It will not work on problems of glasshouse production but will play a supporting role in production for processing where small to medium-scale private companies are increasingly becoming active insofar as small producers are involved.

AVRDC will expand its commodity coverage, without spreading its resources too thinly, by identifying two sets of vegetables: globally-important ones, which will be the primary responsibility of headquarters; and regionally important ones, for which the regional programs will take leadership. Each will be divided into smaller groups, within which the research problems are similar. Initially, headquarters will concentrate on three groups: tomato, peppers, and eggplant; onion, shallot and garlic; common cabbage and Chinese cabbage. The priority vegetables in the different regions will be determined in consultation with national partners through the regional vegetable research networks that will be organized.

In its evolving program strategies, AVRDC will position itself to exploit the special strengths of an international center. It will help accelerate capacity building of its national partners and promote synergy and complementation among them and with its own efforts. It will move progressively towards greater emphasis on strategic research, forging new links with advanced research laboratories to keep abreast of the rapidly advancing frontiers of science and technology. It will strengthen its activities in all aspects of the conservation and distribution of genetic resources; expand its information services; and reorient its training program to focus on research training at headquarters and conduct most of the production training in its regional programs.

While retaining its emphasis on crop improvement as the most cost-effective means of increasing productivity, AVRDC will support an integrated set of research activities aimed at improving both the crop and the environment in which it is grown. It will restructure its programs to give a more comprehensive coverage of problems in vegetable production – from seed production to postharvest handling and distribution.

In implementing the plan, AVRDC intends to retain the present critical mass of effort at headquarters and will shift to a more decentralized mode of operation through the establishment of regional programs which will backstop the regional networks established by its partner countries. This regionalization will enable the Center to get closer to its partners in the national research systems, to respond more effectively to differences in needs and capabilities among regions, and to mobilize capacity both in developing and developed countries to solve problems of common interest. In total, the plan envisages a doubling of the scale of AVRDC's activities in terms of its coverage of regions, commodities and areas of research.

Time and again the international donor and scientific communities have called for an international initiative to promote the production and consumption of vegetables in the developing countries to improve the nutritional well-being and raise the incomes of the poor. AVRDC takes pride in its achievements with limited resources. It is now ready and willing to assume a larger role as a global institution.

Emil Q. Javier
Director General

Introduction

Vegetables comprise a complex group of edible plants with diverse forms of reproduction and propagation, e.g., seeds, cuttings, roots or tubers. They are mainly annuals and biennials whose succulent parts such as leaves, stems, flowers, shoots, roots and tubers are consumed as supplementary foods to diversify the diet. They are rich sources of certain essential vitamins and minerals, and dietary fiber, and provide additional calories and protein.

Economic trends suggest that vegetables will increasingly contribute to improved diets in the developing countries in the future. The adoption of improved varieties and efficient methods of vegetable production has the potential both to raise incomes and give greater equity in their distribution, while improved cultural practices will help to protect the quality of the environment and conserve natural resources. But several obstacles – technical, economic, and institutional – stand in the way of achieving this potential.

The challenge for AVRDC is to help national programs to overcome these obstacles and so contribute to achieving the potential of vegetables to enhance human well-being. This 10-year strategic plan outlines the nature of the challenge and describes AVRDC's vision of the future. It reviews AVRDC's current status as an institution and analyzes the choices it has made in revising its strategy and planning its future activities and programs.

The Challenge

The Importance of Vegetables

There is universal recognition that vegetables are important foods and that vegetable production, marketing and processing are significant contributors to income. Population growth and urbanization are creating increased demand for food, and concerns are rising about malnutrition, especially in peri-urban areas. There is also growing concern that unenlightened methods of vegetable production are having adverse effects on the environment.

Economic Value

Vegetables rank among the most widely grown crops in the developing countries (Table 1). In terms of value of production, vegetables rank even higher than all other cereals except rice, all root crops, and grain legumes.

Table 1. Most important crops in developing countries in order of area harvested and value of production (1979-1981 average).

Area harvested	Value of production
Rice	Rice
Wheat	Sugar cane
Maize	Banana/Plantain
Sorghum	VEGETABLES
Millet	Wheat
Cotton	Maize
Annual Oilseeds	Cotton
Soybean	Coffee
Barley	Sweet potato
Beans	Oranges
Groundnut	Cassava
Cassava	Potato
Sugar cane	Tobacco
VEGETABLES ^a	Soybean
Chickpea	Groundnut
Coffee	Sorghum
Potato	Rubber

Source: Davis, Oram and Ryan, 1989. *Assessment of Agricultural Research Priorities: An International Perspective*. ACIAR Canberra.

^a Vegetable area data are incomplete and reflect principally marketed vegetables only.

Nutrition

Vegetables can provide widely accessible sources of essential vitamins (particularly A, C, niacin, riboflavin and thiamine), and minerals (such as calcium and iron), as well as supplementary protein and calories (Table 2). Some vegetables, such as roots and tubers and leafy greens, are capable of producing protein and calories at rates (per hectare, per day) comparable to those of the most efficient staple cereal crops. Vegetables promote intake of essential nutrients from other foods by making them more palatable. Vegetables provide dietary fiber to improve digestion and health, and they are essential for properly balanced diets.

Vegetables are essential for children, who are nutritionally the most vulnerable group in the population. For example, it has been estimated that, on a world basis, 10 million children under six years of age are deficient in vitamin A and that 250,000 to 500,000 of them are blinded by severe vitamin A deficiency annually. Since fruits and vegetables are known to provide 80% of the vitamin A in diets in the developing world, a greater availability of these produce should significantly reduce this serious nutritional problem.

Table 2. Average nutritive value of vegetables per 100 g edible portion.

	Moisture	Vitamin A ($\mu\text{g RE}$)	Vitamin C (mg)	Protein (g)	Iron (mg)	Calcium (mg)
Tomato	94	111	23	0.9	0.5	17
Hot pepper	89	200	119	1.7	1.3	11
Sweet pepper	92	292	103	1.3	0.9	12
Eggplant	92	83	12	1.4	0.7	6
Onion	89	0	9	1.6	1.0	30
Shallot	84	128	13	2.1	2.0	104
Garlic	88	114	32	2.4	2.0	112
Watermelon	93	150	7	0.5	0.4	14
Cantaloupe	91	9	13	1.2	0.4	14
Cabbage	94	23	41	1.4	0.4	42
Chinese cabbage	94	384	53	1.7	2.6	102
Okra	88	12	8	1.5	1.5	108
Mungbean	10	0	0	23.6	4.4	22
Mungbean sprout	90	12	18	4.2	1.2	15
Soybean	10	6	0	35.1	8.5	226
Vegetable soybean	68	216	27	13.0	3.8	78
Potato	78	0	18	2.0	0.8	9
Sweet potato (orange flesh)	79	145	16	1.6	1.1	72

In the developed countries, average daily consumption of vegetables is estimated to be about 238 g per capita (Table 3). For the developing countries it is only 135 g per capita. Availability per capita per day is estimated at about 60 g in Southeast Asia and sub-Saharan Africa; and 90-100 g in Latin America and South Asia. These average levels do not provide adequate amounts of essential nutrients. Moreover they mask the fact that low-income groups consume less than higher income groups, a pattern that is accentuated in rural areas, where incomes are substantially lower than in urban areas.

Income

In the developing world, most vegetables are produced by small-scale farmers. Production periods are relatively short and productivity per unit area is usually low. However, because of high market prices, incomes per unit area are usually relatively higher. A study in Indonesia in 1985, for example, found that, compared with rice, net revenues per hectare from shallot were over five times as high, from pepper over three times as high, and from tomato almost three times as high. Compared with maize, the differences were double.

Table 3. Population, vegetable production and availability, and per capita income in different regions of the world.

1988	World	All Developed	All Developing	SE Asia	South Asia	China	W Asia/ N Africa	Sub-Saharan Africa	Latin America
Vegetable production ^a (10 ⁶ MT)	426	153	273	14	54	113	42	17	21
Population ^a (Million)	5,115	1,235	3,879	424	1,081	1,111	267	497	430
Vegetable availability ^b (g per capita per day)	160	238	135	63	96	195	305	64	92
GNP per capita ^c (1986; US\$)	3,010	11,270 ^d	619	650	259	300	5,210	603	1,720

^a FAO Production Yearbook, Vol. 42, 1988.

^b 70% of vegetable production assumed as available.

^c World Development Report 1988.

^d Average for 19 industrialized countries.

Vegetable operations are labor-intensive because of the detailed requirements for production and postharvest handling. Vegetable production expands employment in marketing, transportation, processing and export. Moreover, a very large proportion of the work is done by women. Consequently, vegetable production offers not only opportunities for greater incomes to small-scale farmers and low-income laborers, but is especially beneficial for providing employment opportunities for women.

Vegetables have high elasticity of demand. Consumption increases with rising income and urbanization, as vegetables supplement staple foods and add variety to the diet. World consumption rose rapidly (over 3% per year) during the 1970s and 1980s, and is projected to continue to grow aggressively through the 1990s. Increased incomes generated by vegetable production and marketing contribute, in turn, to improvement of nutrition and other aspects of human well-being.

Environment

Unfortunately, vegetable production can have important negative effects on the environment. Many of the vegetables grown commercially in the tropics have been introduced from temperate regions. Owing to poor adaptation to the heat and humidity of the tropical lowlands, these vegetables are commonly cultivated in the highlands where, without appropriate management, they contribute to problems of soil erosion. Moreover, where vegetables are grown for commercial production, farmers use high inputs of chemical fertilizers and pesticides. Use of pesticides is particularly heavy just before marketing and shipping, thus aggravating the threat to human health. Although input-intensive practices have increased vegetable productivity, they have also contributed significantly to environmental pollution.

Better agronomic practices can reduce soil erosion and lower chemical use. Because of the high value of vegetable crops and their adaptability to different cropping systems, manuring and recycling of plant nutrients can be promoted. Moreover, multi-storey and multi-species crop mixtures, which are dominant features of tropical home gardens, can constitute ecologically efficient land management systems, especially if they incorporate leguminous crops. Vegetables grown in multiple-cropping and integrated farming systems, combined with cultural practices that emphasize efficient use of resources and recycling approaches, can therefore minimize degradation of cropland and permit sustainable production in fragile areas.

Moreover, the use of resistant varieties and the widespread adoption of biological control methods and other integrated pest management practices can obviate the need for pesticides.

Constraints to Increased Vegetable Production

Various technical, economic and institutional problems hamper the production of vegetables in the developing countries. Many vegetables are low-yielding, unimproved, traditional cultivars that show limited response to modern production inputs. Farmers in many countries rely on expensive pesticides, even though they may be only partially effective, threaten human health, and pollute the environment. These problems are particularly acute in the low and medium elevation tropics where continuous cropping is practiced, with overlapping production seasons and no cold period to interrupt the life cycles of pests.

Production may be limited by poor management practices which can also contribute to environmental deterioration. Numerous technical and institutional problems also exist, covering various aspects of seed technology, produce marketing, processing and storage. The problems include quality standards, burdensome quarantine requirements and access to markets. Perishability of most vegetables introduces special marketing difficulties, while tradition, lack of education and poorly developed infrastructure often discourage vegetable production and marketing. Moreover, government policies may create economic disincentives to increased vegetable production. While this list of constraints is not exhaustive, it clearly demonstrates the magnitude of the job to be done.

The Role of an International Research Center

Research can make major contributions to solving the problems that limit vegetable production in the developing world. Many major constraints are global in nature and are more efficiently and effectively addressed by a well-staffed and adequately equipped central international entity. However, many more are location-specific. Solutions will often be, at least partly, specific to particular physical, biological and institutional circumstances. National agricultural research and extension systems must address these problems. In these instances, it has been demonstrated as well that international research centers can make the work of national systems more efficient and accelerate the development of solutions.

Many research tasks can be accomplished more effectively when carried out concurrently by several institutions over a broad range of conditions. International institutes can serve as focal points for collaborative research and scientific exchange. They can act as centers for information, sponsoring workshops and conferences, documenting and distributing research results and providing training. They often have advantages in moving people and germplasm across international borders.

Moreover, an international center can build a "critical mass" of scientists that is so important for effective research. Experience has demonstrated that successful research in food commodities has usually required the team effort of specialists working in a range of disciplines – breeding, entomology, pathology, crop physiology, agronomy, soils, statistics and economics – often backed up by scientists belonging to the more basic sciences such as genetics, chemistry and physics. This critical mass can be built in two complementary ways. One is through an international center; the other is through a networking mode of operation, designed to link scientists in different institutions and in different countries.

Unfortunately, horticultural research is accorded a secondary place in priorities for national agricultural research in most developing countries, and few have a critical mass of expertise devoted to vegetables. Cooperation among institutes, universities and agencies is often lacking, resulting in poor exchange of information and duplication of effort.

The key role of an international center is to serve as a catalyst for change, whether in collecting germplasm, generating and disseminating information, providing training, or stimulating the formation of a critical mass for research. Ultimately the task must be accomplished by national systems, but an international center can help national systems achieve desired goals faster and more efficiently.

The Need for a Global Effort

Both in the developing world and among the donor community, interest in a globally oriented, international research effort in vegetables is rising for a number of reasons:

- Concerns about inadequate nutrition and environmental deterioration have focused world attention on vegetables.
- The place of horticulture in developing countries was previously underappreciated because of insufficient emphasis on its economic importance. Perceptions are changing as the rapid growth in domestic and international demand for vegetables and fruits is becoming recognized.
- Although world hunger is far from banished, substantial progress has been made in increasing the production of the main staple foods. National agricultural research efforts in many developing countries are becoming more effective, and confidence has been gained in the power of carefully organized, sustained scientific effort to achieve desirable results. A comparable response has not yet occurred, however, in horticultural crops.
- It has been demonstrated that an international effort such as the one at AVRDC, albeit on a very lean funding base, can produce valuable research results and can contribute effectively to building national research capacity in horticultural crops.

A Vision of the Future

While the results of some research are rapidly applied, the payoff is more commonly of a longer-term nature. Often, results can be expected only 5 years, 10 years, or even longer after the research is initiated. Decisions about research made now will make their impact at some time in the future. It is difficult to project a long way into the future, but a vision of where the world is likely to be many years hence can provide guidance on what research should be done now.

There are many uncertainties, but some changes can be predicted. Population growth will continue, exerting increasing pressure on natural resources, especially on land and water supplies. Urban communities will expand as rural populations seek higher incomes in the towns and cities. The percentage urban population in low income countries (defined by the World Bank as countries with a GNP per capita of US\$580 or less in 1989) has increased from 17% in 1965 to 36% in 1991, or from 300 million people in 1965 to 1,200 million in 1991. This trend of increasing urbanization is expected to continue creating an enormous demand for food and vegetables in peri-urban areas.

Industry and services will continue to grow as developing economies diversify, and there will be increasing opportunities for trade among developing countries. As a consequence, income-generating activities will increase, giving wider access to purchased goods and resulting in changing patterns of consumption. It is likely that additional income will increasingly be devoted to meat, fruits and vegetables, adding variety to diets, especially to those that are heavy in starchy staple foods.

Rapid advances in the biological sciences will continue and affect approaches to research, the scope of problems that can be tackled, and the rate at which success can be achieved. Advances are likely to be particularly rapid in the general area of pest and disease control which, in turn, will affect traditional patterns of agriculture and horticulture. It may take a while and it will be difficult but highly productive yet sustainable practices will be developed for the world's major production areas.

The Center's wish is for the poor people of the developing world to consume a nutritious diet. AVRDC, through its main activities, can make only secondary contributions to improving the calorific content of diets and increasing the supply of protein, but it can make a primary contribution to improving health through the intake of minerals, vitamins and fibers. It can also make significant contributions to raising the incomes of small producers, so that they can afford a nutritious diet. It can assist in ensuring the adequacy of supplies so that vegetables are affordable to low-income consumers. It can make a major contribution to the conservation of genetic resources of the major species of vegetables, and it can help to ensure that vegetable production maintains, if not enhances, the quality of the natural environment.

This vision of a better, more prosperous world for all must, however, be tempered by the reality of poverty and malnutrition that persist in many developing countries. For disadvantaged families, the most direct and cheapest route to better nutrition is through the home garden. Social, cultural, economic, institutional and technical problems retard wider adoption of home gardens. AVRDC can contribute to a better understanding of these constraints and develop principles for their alleviation.

The Asian Vegetable Research and Development Center

AVRDC was officially established in 1971 to collaborate with national governments in order to improve production and marketing of vegetable crops in the lowland tropics. Initially, the focus was on Asia. The selection of Taiwan as the site for this specialized international research and development center was based on several important considerations. Its hot-wet and cool-dry growing seasons permit the continuous development and testing of varieties and practices over a range of environments. The island has a long history as an outstanding vegetable-producing area. It has an excellent institutional infrastructure of farmers' associations, local markets, city markets and supporting agricultural industries, joined by good transportation and communications, all of which serve to make it a good location for regional training. It has outstanding academic and research institutions and a highly trained labor force. And the host government gave and continues to give strong support to AVRDC.

Facilities, Staffing and Operation

The research facilities include a 14-hectare main campus with a research laboratory building, greenhouse complex, genebank and seed laboratory, quarantine house, screenhouses, insectary, training classrooms, administration building, dormitory-cafeteria, residential housing, a multipurpose service building and an experimental farm of 102 hectares. The staff of 21 internationally recruited senior scientists is backstopped by 35 junior researchers and over 300 support personnel.

AVRDC has an agreement with Kasetsart University in Thailand to maintain a regional training center, which accommodates participants from nearby countries and which provides training under wet-hot and dry-hot production environments. AVRDC coordinates a research network in Southeast Asia and has had bilateral programs in Indonesia, Republic of Korea, Malaysia, the Philippines and Thailand, and in Niger in Africa and Trinidad in the Caribbean.

AVRDC has conducted intensive research on six primary commodities: Chinese cabbage, mungbean, pepper, soybean, sweet potato and tomato. Varietal and production trials are also being carried out with other vegetables, e.g., broccoli, carrot, cucumber, eggplant, hyacinth bean, kangkong, leaf amaranth, leaf lettuce, Malabar spinach, non-heading brassicas, onion, spinach and yardlong bean.

In recognition of its broad international concerns, programs, and linkages, AVRDC is supported by a wide range of donors, its core programs being supplemented by a number of special projects. Its current donors are listed in the box below.

Donors of AVRDC	
<i>Core and Restricted Core</i>	<i>Special Projects</i>
Australia	Asian Development Bank
Republic of China	Japan Shipbuilding Industry Foundation
France	Council of Agriculture (ROC)
Germany	National Science Council (ROC)
Japan	ACIAR (Australia)
Republic of Korea	GTZ (Germany)
Philippines	IDRC (Canada)
Thailand	(SDC) Switzerland
United States of America	USAID
World Bank	Technical Centre for Agricultural and Rural Cooperation (CTA)
	International Potash and Phosphate Institute
	International Board for Plant Genetic Resources (IBPGR)

Achievements

AVRDC was conceived as a focal point for bringing together knowledge, expertise and genetic resources to address urgent horticultural issues in tropical Asia. The highlights of its achievements are listed below:

- AVRDC has assembled one of the world's largest vegetable genebanks and has been recognized by the International Board for Plant Genetic Resources (IBPGR) as the world base collection of mungbean, the Asian and Pacific collection of sweet potato, and the global duplicate collection of peppers.
- The Center's breeding programs have raised the yield potential of its six primary commodities, especially when grown under high temperature conditions, and have developed lines with improved quality and resistance to major diseases and pests. By

1989, 148 tomato varieties derived from AVRDC breeding lines had been officially released in 30 countries. AVRDC's improved grain and vegetable varieties of soybeans occupy about 50% and 90%, respectively, of the soybean areas in Taiwan. In Indonesia 360,000 hectares, and in Thailand, 70,000 hectares, are planted to improved soybeans that have at least one parent from AVRDC's improved lines. AVRDC's improved mungbean varieties were planted on about 250,000 hectares in China in 1986. AVRDC's heat-tolerant Chinese cabbage hybrids are now helping increase vegetable production during summer in China.

- AVRDC has made improvements to production systems for the tropics that reduce weeds and soil-borne diseases, alleviate the effects of high rainfall and excessive soil moisture, improve fertility and structure of soils, and use integrated management methods to reduce pests.
- AVRDC has trained over 1,000 vegetable researchers and extension workers from more than 50 countries or territories, and has provided a continuous flow of scientific and technical information to the vegetable community throughout the world.

Mission

Based on its accumulated experience of the needs of developing countries, AVRDC restates its mission statement as follows:

The goal of AVRDC is to enhance the nutritional well-being and raise the incomes of poor people in the rural and urban areas of developing countries, through improved methods of vegetable production, marketing and distribution, which take into account the need to preserve the quality of the environment.

Main Activities

AVRDC seeks to achieve its goal through three groups of activities:

- the conservation of vegetable genetic resources and their use for crop improvement;
- research to generate new knowledge and technological innovations for increased productivity, with particular attention to sustainability and the prudent use of inputs; and
- strengthening national research capacity in the developing countries through information services, training and collaborative research.

Values

AVRDC lives by certain values that constitute the institution's guiding principles. They affirm AVRDC's reason for being. They are the prisms through which the center perceives its environment – the problems, challenges, and opportunities – and its proper place in the larger world. They govern AVRDC's relations with all its stakeholders – its partners, clients, beneficiaries and donors.

Apolitical philosophy. As an international center, AVRDC conducts its business with any individual or institution that shares AVRDC's goals, regardless of political ideology, race, language or religion.

Technological change as a primary vehicle for progress. AVRDC's founders were convinced that technological change is critical for growth in agricultural production in the developing countries. However, technological change should be managed not only to improve productivity, but also to do so in ways that are equitable and sustainable.

Excellence in research. Relevant and successful technology is derived from scientific research, which is AVRDC's primary activity. The center pursues its primary activity with dedication and commitment to excellence.

Teamwork and multidisciplinary analysis. AVRDC recognizes that its purpose can be achieved only through collaboration among scientists from different disciplines. To that end its programs encourage a multidisciplinary team approach to research problems.

Partnership. AVRDC's goal is shared by those national institutions that are responsible for agricultural policy, research, extension and production, whether in the public or private sectors. AVRDC's basic role is to make national institutions more effective, not to substitute for them. AVRDC works with and through these organizations in partnership. AVRDC consults with its partners in setting its priorities and in arriving at an appropriate division of labor that optimizes complementarity and synergy.

Sensitivity to gender issues. Women play a major role in the cultivation, marketing and consumption of vegetables in the developing countries. Enhancing the role of women is an important consideration in our research agenda.

Accountability for achievements and impact. AVRDC recognizes that it is a steward of resources provided by society at large. The goal it has set for itself is one it shares with many institutions both national and international, public and private. Although exclusive attribution of achievements is difficult, AVRDC constantly relates its use of resources to the achievement of its goals. It devises measures of progress to provide guidance to itself and its partners on how best to conduct its business, and to justify to all concerned the ways in which its resources are used.

Efficiency. AVRDC takes pride in having done so much with so little. It intends to operate as frugally in the future as it has in the past.

Strategic Choices

The problems facing vegetable production, and the associated opportunities for research and development in the Third World, far exceed AVRDC's capacity to respond. In making difficult choices, AVRDC has tried to be objective, and has kept in mind the level of resources potentially available, the capacity and need of our national partners, and the state of the art in the relevant fields of science.

Which Regions?

In determining which geographical regions should be emphasized and what method of operation would be most appropriate in each region, AVRDC has taken into account the following factors: the importance of vegetables in the region, as reflected in statistics for production and consumption; the relative magnitudes of populations nutritionally at risk; the main agroecosystems and major production systems in relation to AVRDC's comparative advantage; the opportunities for achieving widely applicable results through spillover effects; and the interest and strengths of national programs.

Asia

One half of the world's poor live in Asia. It contains four-fifths of the world's vegetable area and accounts for about 60% of production. Vitamin A deficiency is found throughout the region wherever rice-based diets predominate. Pesticides are used heavily for vegetable production.

Developing Asia consists of three main subregions. Southeast Asia has very low per capita consumption of vegetables but rapidly increasing demand (Table 3). It has a humid tropical climate for which AVRDC is well placed to do research. There are moderately well-developed national research systems, and the governments have demonstrated their commitment to vegetable research. Indeed, several of them have contributed funds for core AVRDC activities, bilateral programs and networks. There is increasing private sector participation in the seed trade and in production for

processing and for export. The countries in the region currently participate in a productive research network called AVNET (Collaborative Vegetable Research Network in Southeast Asia).

South Asia, with 1 billion people, has very low income and vegetable consumption per capita. The rate of income growth is also generally low. Some of the countries in the region have strong research systems. AVRDC exchanges germplasm and information with all the countries in the region and coordinates the newly established regional vegetable network, SAVERNET (South Asian Vegetable Research Network). The Center currently has a bilateral program with Bangladesh.

Mainland China, with a population of over a billion, has low per capita income but a moderately high level of vegetable consumption. It has a well-organized research and extension system that is effective in exploiting the benefits of improved technology. There is a large potential for AVRDC to contribute to productivity of summer crops. China is an excellent source of vegetable germplasm.

Sub-Saharan Africa

The vast continent of Africa has a wide range of ecological conditions. Vegetable production is generally low throughout sub-Saharan Africa, and vitamin A deficiency is strongly associated with cassava-based diets throughout the region. Vegetable research in the national systems is generally weak, and with a few exceptions, the private sector is not active in vegetables. The deteriorating food situation means that considerable attention must still be devoted to increasing the production and availability of staple food crops.

Nonetheless, vegetables are increasingly being recognized as important for nutrition and income, especially near urban areas. AVRDC has had direct collaboration only in Niger, although it has trained many African researchers and extension workers. Some larger countries such as Nigeria, Senegal, Kenya and Ethiopia have expressed interest in establishing bilateral relationships with AVRDC. The Southern African Development Coordination Conference countries, through their regional research arm, SACCAR (Southern African Centre for Cooperation in Agricultural Research and Training), have decided to step up activities in vegetables and fruits, and a proposal for the SACCAR-AVRDC regional Collaborative Network for Vegetable Research and Development in Southern Africa (CONVERDS) has received initial funding from some donors.

Latin America and the Caribbean (LAC)

In South America, vegetables are important for diet and income primarily in and near the urban areas. Some countries are large exporters. In Central America, vegetable exports, especially to the United States, constitute a particularly promising means of raising incomes of the rural poor. National programs are generally weak but private export companies are active. AVRDC has a memorandum of understanding with IICA (Inter-American Institute for Cooperation on Agriculture) and with the Tropical Agricultural Research and Training Centre (CATIE). In the Caribbean, a fair amount of vegetables are produced for the tourist trade and exported. AVRDC has collaborated with the Caribbean Agricultural Research and Development Institute (CARDI).

West Asia and North Africa (WANA)

Vegetables are important for nutrition and income in West Asia and North Africa, and are especially important for foreign exchange. A few countries have relatively strong research structures, and the private sector is active in research and export marketing. Because of the arid and semi-arid environments, a lot of the vegetable production occurs under irrigation or greenhouse conditions. Tomato, eggplant, cucumber and melons are the most important vegetables. Up to the present, AVRDC has had no experience working in these Mediterranean environments and has had little direct collaboration on research or training with scientists and extension workers in the region.

Priorities

AVRDC will place first priority on Asia, because, on a world basis, it has by far the greatest number of poor people and those at risk from malnutrition. It also has the greatest area under vegetable production in the developing world and is therefore likely to yield the greatest return from activities promoted by AVRDC.

AVRDC places second priority on sub-Saharan Africa, because of the deteriorating food situation in that region and the potential of vegetables to contribute both to increased incomes and to improved nutritional well-being.

Latin America and the Caribbean will be accorded third priority. AVRDC regards LAC as having lower priority than sub-Saharan Africa because of the activities of other organizations in the region with interests in vegetables, such as IICA, CATIE, CARDI, CIAT (Centro Internacional de Agricultura Tropical) and CIP (Centro Internacional de la Papa). Nevertheless, AVRDC can make an important contribution, especially because of its experience in the Asian humid tropics, much of which is likely to be transferable to vegetable production in similar ecosystems in the LAC region.

AVRDC places fourth priority on West Asia and North Africa. Vegetable availability is relatively high in the region. Moreover, AVRDC has, so far, had no experience working in Mediterranean environments. It will begin work in the region, however, and expects its genetic materials to have some value to national crop improvement programs, because of their heat tolerance, resistance to pests and diseases, and horticultural quality.

Which Agroecological Zones?

Vegetables are grown in all the agroecological zones of the developing countries, both in the tropics and subtropics. They may be grown in multiple cropping systems throughout the year or in specific growing seasons, determined by rainfall, temperature or both. If AVRDC were to seek solutions to problems in all agroecological zones, however, it would be at risk of spreading its resources too thinly.

Fortunately, for some vegetables, the requirements for broad adaptation are not as stringent as with agronomic crops. Farmers often are able to provide vegetables, which are high value products, with supplemental water, adequate manuring and other soil amendments and protective devices such as raised beds, shades, windbreaks and mulches in the field.

For these reasons many vegetable varieties can be grown over wide geographical areas, and improved practices developed in one agroecological zone can often "spill over" into others. Indeed one way of maximizing the benefits of international research is to identify those innovations or cultivars that are likely to show the greatest spillover effects.

Priorities

AVRDC will contribute to increased and more sustainable vegetable production in a wide range of ecological zones by adopting two complementary strategies. It will exploit opportunities for division of labor between headquarters and its regional programs; and it will select problems that present the greatest opportunities for spillover effects.

At headquarters, it will give first priority to the humid and subhumid tropical lowlands. It is these broad ecosystems in which AVRDC's main experience is based. They are extremely important for vegetable production throughout the developing world and there are good prospects of spillover effects to other regions from both the work in crop improvement and that on production systems.

As second priority, headquarters will work on the problems of vegetable production in the tropical highlands. In general it is in this agroecological zone that the threat is greatest to the environment. The principles of sustainable production developed for the tropical highlands are likely to have wide applicability to highland areas across the regions.

In order to broaden its overall coverage of agroecosystems, AVRDC, through its Regional Programs, will work with its partners to identify the most important ones on a regional basis. The regional programs through the networks will develop germplasm and improved practices adapted to the specific needs of particular agroecological zones.

Which Production Systems?

Production systems for vegetables vary from the cultivation of a few plants in the backyard for home consumption, to large-scale intensive production for marketing, processing or export. For purposes of classification, five vegetable production systems are generally recognized: home gardens, market gardens, truck gardens, production for processing and vegetable forcing.

Home gardens are defined as family-managed production systems, designed to produce food and fiber, as well as ornamental and medicinal plants, primarily for family consumption and secondarily for sale. Market gardening is designed to supply local markets and truck gardening, distant markets. Both market and truck gardening are commercial production systems, are usually intensive and have similar research requirements. Production for processing is usually organized by small to medium-scale agribusiness companies and vegetable forcing is mainly done in capital-intensive glasshouse operations.

Priorities

AVRDC will give first priority to market gardening and truck gardening. They are important not only because of their contribution to marketable production and income generation, but also because improvements in small-scale market production systems may spill over to home gardens, leading to the more general commercialization of vegetables and other associated benefits.

AVRDC will give next priority to home vegetable gardens because they provide opportunities for poor rural and urban families to obtain nutritious food inexpensively. Moreover, they present opportunities for sustainable production in that organic matter and water from the home can be recycled. Although they are popular

in traditional agricultural societies, their appeal seems to be diminishing, despite the intensive promotional efforts by nongovernmental organizations (NGOs), UNICEF and other international and national public organizations. Careful assessment of the underlying causes of their decline is a prerequisite for future success.

AVRDC does not intend to deal with vegetable forcing or vegetable production in glasshouses, although it will investigate the use of lightweight materials in the field to protect crops and extend the growing season. In the case of production for processing, typically, they are organized by small to medium-scale private companies which may or may not have their own research and extension services. AVRDC will play a supporting role to these private agribusiness initiatives insofar as they involve small producers. Where appropriate AVRDC will include breeding materials with suitable processing qualities as adjuncts to the main breeding programs.

Which Vegetables?

Few of the technological innovations that AVRDC will help to develop will be totally independent of the particular species or type of vegetable to which they will be applied. This consideration is especially important for certain aspects of the work, such as the application of modern biotechnology to crop improvement. While the number of potential candidates in the total array of tropical vegetables is relatively large, AVRDC must guard against spreading its resources too thinly.

Although, for this reason, AVRDC has hitherto restricted its attention to only a few species, all the regional research consultations conducted so far have stressed the need to broaden the Center's commodity scope to reflect the diversity of preferences in different parts of the world. There is clearly a trade-off, however, between the number of individual vegetables that can be included and the likely success of the work undertaken.

In seeking to strike a reasonable balance between these two conflicting requirements, AVRDC has first reconsidered the relative importance of the various candidate vegetables and then introduced new ways of using its limited resources to give effective coverage to as many of them as possible. The main considerations that were taken into account in assessing candidate vegetables were: direct contribution to nutrition (Table 2), economic importance and relative distribution among regions (Table 4), likely success of research, AVRDC's comparative advantage, research being undertaken by other international organizations, and interest by stakeholders.

Table 4. Most important vegetables (in terms of area harvested, in hectares) in the major developing regions of the world.

	All developing countries	SE Asia	S Asia	China	Latin America	Sub-Saharan Africa	W Asia/ N Africa	World
Tomato	1593	69	99	343	314	171	555	2725
Onion	1297	174	413	243	167	78	210	1908
Watermelon	1169	48	-	325	160	5	606	1931
Peppers	882	148	87	168	103	158	100	1057
Cabbages	810	67	103	458	44	8	59	1695
Cucumbers	490	74	6	245	31	-	126	880
Melons	428	4	10	125	78	1	201	631
Gourds	412	23	23	98	131	21	106	586
Eggplant	390	103	-	179	1	7	94	432
Garlic	374	56	114	73	45	1	31	490
Green peas	262	10	96	58	69	1	29	778
Green beans	250	44	36	47	35	1	86	451
Carrot	238	8	1	126	46	-	50	615
Cauliflower	208	5	102	80	4	-	106	407

Source: FAO 1989 Production Yearbook, vol. 43, 1990.

True vegetables

According to FAO statistics, the six most important "true" vegetables in the developing countries in terms of reported area (Table 4) are as follows (relative importance indicated on a scale of 10):

- 10 tomato
- 8 dry onion
- 7 watermelon
- 6 peppers
- 5 cabbage
- 3 cucumber

Tomato is the most important and very widely popular vegetable in all developing countries. It is moderately high in vitamins A and C, high in cash value, and has a high potential for value-added in processing. It presents several researchable problems, including tolerance to heat, drought and flooding; damage from pests and diseases; and quality. AVRDC has 15 years of experience in research on tomato with a rich record of accomplishment and strong research relationships. Nevertheless, many problems have not yet been alleviated. Tomato was included in the top priority group by all scientists interviewed in a study commissioned by TAC (Technical Advisory Committee) of the CGIAR (Consultative Group on International Agricultural Research).

Dry onion is second and is also popular in all regions. Statistics for shallot and garlic are often mixed with those for bulb onion. Onion is a high-value cash crop. It has reasonably high nutritional value and makes other nutritious foods more palatable. Little research has been done on tropical bulb onion, shallot or garlic, for which the cultural requirements and researchable problems are similar, and the prospects for impact from research are good. Onion was also included in the top priority group in the TAC study.

Watermelon ranks very high in popularity, primarily in Northeast Asia and WANA, which are not among the highest priority regions for AVRDC involvement. Although not particularly nutritious, watermelon is a high-value cash crop and commands strong research support from the private sector.

Peppers, both hot and sweet, are probably the most evenly popular vegetables in all regions. They are rich in vitamins A and C, niacin, riboflavin and thiamine. They make other nutritious foods more palatable. Peppers present several researchable problems including quality and damage from diseases, particularly viruses. Hot peppers (chilies) were included in the top priority group in the TAC study.

Cabbages are the only leafy vegetables in the top five most important vegetables, assessed on the basis of all developing countries. Common cabbage is more generally grown than Chinese cabbage, which is popular in mainland China, Korea and Taiwan and is becoming popular in Southeast Asia. Common cabbage has moderate amounts of vitamins A and C and calcium; Chinese cabbage has high amounts of each plus iron. Lack of adaptation to high temperature is the primary constraint to increased production, but breakthroughs have been achieved in this regard. Heat-tolerant common cabbage hybrids are already being aggressively marketed by private seed companies. For its part, AVRDC has developed heat-tolerant Chinese cabbage populations and hybrids, but control of pests and diseases remains a severe problem.

Three other vegetables are important although they are commonly overlooked. Eggplant/brinjal is only moderate in its nutritional composition, but it is an important supplier of nutrients because of its low market price and large consumption, and it is high in total economic value. It has close affinity to tomato and pepper, and their research needs are related. It is not included in AVRDC's current program, but interest is very high in Asia and Africa, and it received considerable support from scientists and administrators in the TAC study. The total area planted to eggplant is underreported in FAO statistics owing to nonreporting of production from South Asia, but it belongs easily to the top ten.

Okra (lady finger) is also widely cultivated in the tropics, and it was described as receiving considerable support in the TAC study. It is very high in calcium. Among the factors limiting its productivity are virus diseases and high susceptibility to whitefly. Finally, there are the leafy green vegetables, which are exceptionally good sources of vitamins A and C, protein, iron and calcium. There are many kinds of leafy green vegetables and they differ widely in popularity from locality to locality. In Africa, green vegetables, such as local spinach types, received higher priority than any other vegetable reviewed during the TAC study. In Asia, leafy green vegetables are seen as important but less in need of research than other crops. In Latin America, they may have been placed well below other crops because they are grown primarily in home gardens and are not widely marketed.

Legumes

Statistics for leguminous crops relate to their importance as grain legumes, but they are also important as vegetables. In general, their requirements for increased productivity as grain crops are highly correlated with those for their performance as vegetables. The most important crops in terms of reported hectareage (on a scale of 10) based on the most recent FAO statistics are:

<i>All Developing Countries</i>	<i>Asia</i>
10 soybean	10 dry beans
9 dry beans	9 groundnut
6 groundnut	9 soybean
3 chickpea	6 chickpea
1 dry broadbean	2 lentils

Although not yet widely grown in Africa, soybean is the most important legume in developing countries at large. A lot of soybean is utilized as human food in Asia but increasingly there are significant importations for animal feed. Vegetable soybean is popular in China, Korea and Japan and has been introduced into the ASEAN countries. Both production and imports are rising rapidly in Asia. Soybean is high in protein, iron and calcium. It is a mandated crop for IITA in Africa. INTSOY, which is an international research program based in the USA, focuses on soybean processing research.

Dry beans include a number of species. Mungbean accounts for almost half the dry beans grown in South and Southeast Asia; elsewhere, Phaseolus dry bean is predominant. Mungbean is high in protein and calcium. Phaseolus bean, groundnut, chickpea and lentil are mandated crops of CGIAR Centers (CIAT – Phaseolus bean; ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) – groundnut and chickpea; ICARDA (International Center for Agricultural Research in the Dry Areas) – chickpea and lentil). Although the CGIAR Centers are working on these crops mainly as grain legumes, they also keep in mind their importance as vegetables.

Roots and tubers

The most important roots and tubers (on a scale of 10) are:

<i>All Developing Countries</i>	<i>Asia</i>
10 cassava	10 sweet potato
6 sweet potato	6 potato
4 potato	5 cassava
2 yam	1 taro

All of these (except taro) are included in the programs of one or more of the CGIAR Centers. CIAT has a global program on cassava, while IITA (International Institute of Tropical Agriculture) has a program in Africa on cassava and yam. CIP has global programs in both potato and sweet potato. AVRDC dropped potato as a principal crop in 1979, but continued its program in sweet potato until 1991.

Priorities

AVRDC will gradually broaden its present narrow commodity scope by adopting two complementary strategies, similar to those it has applied to choices among agroecological zones. First, it will exploit opportunities for division of labor between headquarters and its regional programs, by identifying two sets of vegetables: a set of globally important species designated "principal crops", which will be, primarily, the responsibility of headquarters; and a set of regionally important commodities, designated "regional crops", which will be the responsibility of the regional programs. Second, each of these main sets of vegetables will be divided into smaller groups, within which the research problems are broadly similar.

For the principal crops, AVRDC proposes to conduct comprehensive research on the following three groups:

Solanaceous crops:	tomato, pepper, eggplant
Allium bulbs :	tropical bulb onion, shallot and garlic
Crucifers :	common cabbage and Chinese cabbage

All of these are among the most important vegetable commodities in the developing countries and research on them can be effectively undertaken at headquarters.

As far as the leguminous crops are concerned, AVRDC has taken into account the fact that other international centers are working on most of them with the exception of mungbean and, in some regions, soybean. Practically all the mungbean in the world is grown in Asia. Our Asian partners urge that AVRDC should continue its highly successful research program on mungbean, even though a number of them have developed significant research capacity on this crop. AVRDC therefore proposes to devolve the present mungbean program at headquarters to the proposed Asian regional program based in Thailand, which will work closely with strong national programs in India, Indonesia, Pakistan, the Philippines and Thailand.

In the case of soybean, it is a principal crop at IITA for Africa while CIAT has decided recently to take on soybean for Latin America. Soybean is a very important commodity in Asia too. The Asian Grain Legumes Network supported by the United Nations Development Programme (UNDP) and ICRISAT excludes soybean. ICRISAT has indicated it has no intention to take on soybean in this region, because it is produced primarily in subhumid or humid ecosystems, which lie outside ICRISAT's ecological mandate. In order to continue work on this important crop for the region, AVRDC proposes to devolve its present soybean program to its Asian regional program in Thailand.

Other regionally important vegetables will be identified in the consultations AVRDC is organizing to determine research priorities and preferred modes of collaboration. Without preempting the outcome of these consultations, the regional programs may include the following crops:

-
- Asia
 - mungbean, soybean, yardlong bean and snap bean^a
 - important Asian vegetables, e.g., okra, amaranth, water convolvulus.
 - Sub-Saharan Africa
 - important African vegetables, e.g., amaranth, spinach; okra also very important.
 - LAC
 - important South American vegetables, e.g., cucurbits.
 - WANA
 - watermelon and other melons.

This combination of principal and regional crops will mean that future international coverage of tropical vegetables will be much more comprehensive than in the past. It is important, however, to avoid undesirable duplication. Accordingly, AVRDC is already making an orderly transfer of its research activities and germplasm responsibilities in sweet potato to CIP and interested national programs.

^a *The bulk of the world's snap bean is grown in Asia. CIAT is considering whether to expand its present dry bean program to include snap bean (fresh pod) particularly directed to Asia. The AVRDC Asian Regional Program can be CIAT's partner and conduit in Asia.*

A Note on the Special Role of Women

Women play a major role in the cultivation, processing and marketing of vegetables in developing countries. Intensive production of vegetables is often associated with the availability of female labor; it is probable that women will determine whether or not new technology is implemented; and they are the most likely to be affected by changes in vegetable production.

Women contribute significantly to household incomes through vegetable production and marketing. Rural women work long hours in commercial production in order to spend a higher proportion of their incomes on family welfare, and they frequently have primary responsibility for meeting the needs of household consumption. Improving rural welfare is inseparable from expanding the earning opportunities of rural women. Any technology that raises rural women's productivity will be particularly beneficial to the welfare of rural households.

Furthermore, women, as homemakers in rural areas, work long hours on subsistence needs in their homesteads to provide supplementary food to their kin. Women normally make important decisions about how food is to be distributed among members of the household. Planning and implementing programs that take into account knowledge of the nutritional impacts of vegetables, including judicious selection of vegetables for backyard use, will contribute directly to improving the nutrition of the entire family.

Since women are the pivot between production and consumption in rural economies, the role of women will receive special attention in the Center's research and development programs. Gender analysis will be included in socioeconomic studies; specific attention will be directed towards supporting the role of women in vegetable production, processing and marketing.

Program Strategies

The achievement of AVRDC's goal will involve contributions from numerous institutions and individuals. AVRDC recognizes that it is only one actor among many and that it must choose those activities for which it is best suited and which have the maximum chance of being widely beneficial to others. In many of its activities, AVRDC will act as a catalyst, influencing and assisting others in ways that enable them to contribute to the common purpose. Guided by these basic principles, AVRDC has redefined its strategy for each of its programs, and has set targets by which progress will be monitored.

Research

AVRDC will position itself in the overall spectrum of research (basic, strategic, applied and adaptive) so as to exploit its special strengths and to capitalize on its partnerships with national programs. It will concentrate on those aspects of strategic and applied research that have the greatest potential to give widely applicable results and, for its requirements in more basic research, it will rely largely on other research organizations both in the developed and developing countries.

AVRDC will keep abreast of developments in the rapidly advancing fields of modern biotechnology through professional interaction and access to information. Opportunities will be sought to bring to headquarters postdoctoral fellows, and visiting scientists on sabbatical leave, who will spend a year or two at the Center to work closely with Center scientists, to introduce new skills, and help to forge new links with research institutions throughout the world. The Center will likewise explore possibilities for placing some of its staff for certain periods of time in advanced laboratories where appropriate facilities and skills are available to conduct collaborative strategic research on problems of urgent interest to AVRDC and its national partners.

AVRDC will do adaptive research only to the extent necessary to develop and test varieties and management systems under specific conditions. Its involvement in adaptive research will be largely indirect through its collaboration with national programs and its participation in networks.

Elements of the research program

Because of the potential for crop improvement to increase vegetable productivity in the developing countries, AVRDC's primary research activity will continue to be plant breeding, increasingly reinforced by the application of modern biotechnology. To support this primary approach, AVRDC will:

- expand its program on genetic resources, particularly for its principal and regional crops;
- build capacity in the application of modern biotechnology;
- strengthen its research efforts to understand the bases of plant resistance to biotic and abiotic stresses;
- and initiate research on the technology of seed production, processing and testing.

In its contributions to research for improving the crop environment, AVRDC will:

- strengthen its research on sustainable production systems;
- widen the scope of its research on integrated pest management;
- adopt a systems approach to research on home gardens;
- build its research capacity in socioeconomics; and
- initiate research on postharvest problems.

Plant breeding

The genetic improvement of vegetable crops still provides the most cost-effective means of increasing and stabilizing vegetable production in the developing countries. In collaboration with its partners, AVRDC will continue its efforts to minimize biotic and abiotic constraints to production and improve quality, through breeding.

As the number of breeding objectives increases, localized selection will become increasingly important. To help national agricultural research systems develop and select more appropriate varieties, AVRDC will continue to offer genetically diverse populations carrying major characteristics of interest. As the capabilities of national programs grow, AVRDC will gradually shift from offering nearly finished lines for selection to offering more diverse populations for further manipulation.

Conservation of genetic resources

Greatly increased effort on the ex situ conservation of vegetable germplasm (i.e., collecting, documenting and storing) has become urgent because of universal genetic erosion. The germplasm must be collected now and preserved for use both in active plant breeding programs and to meet future needs. Accordingly, AVRDC will expand its program on genetic resources particularly for its principal and regional crops. Where opportunities arise, AVRDC will arrange with interested national agricultural research systems to accept primary responsibility for species of great interest to them, e.g., yardlong bean by the Philippines, Malaysia or Indonesia. In other vegetables, initial efforts will be limited to accepting collections for storage (and regeneration of those in immediate danger of losing viability).

The long-term objective will be to assemble a comprehensive collection of the Center's principal crops, as well as the major vegetable crops in each of the regions, including indigenous species. Known gaps in current collections will receive highest priority for future collecting. In total, this is an enormous task and will require the mobilization of the capacity of our national and regional partners, working under the auspices of IBPGR and FAO, and building on the principle, recently established by IBPGR, of forming crop genetic resources networks. AVRDC headquarters will be primarily responsible for the center's principal crops, while primary responsibility for the other important vegetables will rest with the regional programs, working closely with the appropriate national or regional genebanks. However, headquarters will maintain a duplicate collection for all the regionally important species.

Uniform documentation criteria will be developed, and the collections will be evaluated for resistance to biotic and abiotic stresses of high priority. To facilitate evaluation, the Center will enlist the cooperation of interested and capable national and regional genebanks, as well as plant breeders in collaborating national programs. AVRDC will work with IBPGR and other national and international centers to develop appropriate technology for the multiplication and conservation of vegetable germplasm and their safe handling and distribution.

Germplasm with the desired traits, properly characterized and documented, and free from pests and diseases, will be multiplied and distributed to cooperating national programs. Information services and training will be strengthened to facilitate this process.

Biotechnology

In building its capacity for the inclusion of modern biotechnology in its research approaches, AVRDC will give priority to those techniques that show promise of reinforcing conventional approaches to problems on which progress has been slow. Possibilities for using techniques in molecular biology and recombinant DNA will be actively explored, especially those diagnostic and monitoring techniques that facilitate pathogen identification and the monitoring of progress in the introgression of desirable genes from wide crosses. Opportunities for incorporating novel genes by transformation will also be explored, such as those conferring resistance to insect pests and virus diseases.

In this work AVRDC will rely heavily on collaboration with advanced laboratories to adapt known technology for use with AVRDC's designated principal and regional crops. AVRDC will progressively build up its own expertise in the application of techniques judged to be cost-effective, and assist its partners in national programs to do likewise.

Biotic and abiotic stresses

Plant breeding improvements are based on systematic attempts to take advantage of increased knowledge arising from research in disciplines such as genetics, pathology, entomology and physiology. AVRDC will increase its strategic research in these disciplines to obtain greater understanding of the nature of tolerance and resistance to biotic and abiotic stresses, to develop more effective ways of approaching multiple breeding objectives, and to identify new sources of tolerance or resistance.

Studies on topics such as race or strain differentiation and distribution, and the physiology of host-parasite relationships will be explored, and improved screening techniques developed for the more important disease, insect and nematode problems. Many of AVRDC's advanced breeding lines already carry resistance or escape mechanisms. In these instances, further effort will be devoted to finding higher levels or more durable forms of resistance, or refining screening protocols.

Seed technology

Inappropriate varieties, undesirable mixtures, inferior packaging and poor germination are common problems of the seed supply for commercial vegetable production, as well as for home gardens, in developing countries. Seed production is a major limiting factor and seed quality variable. There are many technical problems in both production and storage. In many

developing countries, seed production is entirely in the hands of public agencies and parastatal bodies, but private sector participation is increasing in some.

In cooperation with its partners, AVRDC will collect and distribute information, and initiate research on the technical requirements and appropriate infrastructure for the production, processing, testing and storage of vegetable seeds, concentrating on its principal and regional crops and collaborating with both the public and private sectors, as appropriate to the local circumstances in each country. Efforts will initially be modest, but will increase as resources permit. Priority will be given to assembling relevant information, mobilizing support from institutions with expertise in this area, and initiating collaborative research projects.

Sustainable production systems

The future strategy of crop and resource management research will be to address the needs of the vegetable industry from sowing the seed to bringing the product to the market. The objective is to generate and transfer information and production technology that will promote efficient, economic and sustainable use of resources and promote efficient distribution systems.

Vegetables in the tropics often yield much less than their genetic potential. Yields tend to vary considerably from season to season and from year to year while, on continuously cropped land, they tend to decline. A range of abiotic factors contribute to these results, including soil quality (acidity, infertility, poor texture, salinity and topography), temperature, water supply and quality, daylength and light intensity. Invariably, these factors interact with each other and with the biotic factors that also limit yields and cause variability. Improved production systems and better management can contribute to the alleviation of many of these problems.

AVRDC's work on cropping systems will be firmly based on research in soil science, physiology and crop management to develop environmentally sound production methods. Cropping systems research will investigate ways of integrating new varieties and production methods into existing and new production systems. AVRDC will concentrate on problems related to the maintenance of soil productivity, with particular emphasis on the prudent use of inputs. To complement the work on genetic improvement, attention will also be given to management practices that reduce abiotic stresses.

In cooperation with its partners, AVRDC will strengthen crop and resource management research. Yield potentials of principal crops in major growing environments will be established, and the relationships among the biological, physical, sociological and economic components of major vegetable production systems will be investigated. Initially, the aim will be to determine priorities by identifying the most important factors that constrain productivity and threaten the environment. The program will progressively focus on problems of high priority that maximize opportunities for spillover effects.

Integrated pest management

AVRDC's major approach to controlling vegetable pests and diseases has been to breed resistant or tolerant cultivars. Some success has been achieved, especially with resistance to diseases. However, where little or no resistance is available, or where the pest organism develops new races or biotypes quickly, alternative control measures have been considered such as in the highly successful control of diamondback moth in cabbage with released predators.

In recent years, vegetable growers have been using increasing quantities of chemical pesticides. Although some chemicals continue to be useful, concern over rising costs, health hazards, environmental contamination, and development of pesticide resistance is mounting. To meet these challenges AVRDC will use its research capacity in pathology and entomology to reinforce its plant breeding approach and develop integrated packages for the control of the most important pests for which there is currently inadequate host-plant resistance. This work will be conducted in close collaboration with research on cropping systems to exploit opportunities for reducing pest population through crop management and diversity.

Socioeconomics

AVRDC recognizes that sound socioeconomic information is essential for informed planning of research programs. In building its research capacity in socioeconomics, AVRDC will develop data bases, study constraints to adoption of improved technology, assist in defining research objectives more precisely, analyze the economics of technological innovations before they are recommended, analyze and monitor the impact of improved vegetable varieties and cultural practices, and study marketing and trade opportunities. AVRDC proposes to mount a modest program of policy research, initially relying heavily on cooperation with other international agricultural research centers, as well as with regional and national research institutions, for much of the actual research.

More specifically, AVRDC will work with its partners in national research systems and with FAO and the other international and regional agricultural research institutions to:

- establish and maintain reference information for vegetable production and consumption;
- identify and analyze the characteristics of production and marketing systems;
- review policy environments for vegetable production and marketing;
- develop methods for monitoring and evaluating the impact of the results of AVRDC's programs and those of its partner countries;
- facilitate linkages between farmers and research scientists to improve the feedback of information and ensure the relevance of research.

Home gardens

Home cultivation of vegetables is a traditional way of providing variety and enhancing the nutritional quality of the family diet. However, the yield of vegetables produced in home gardens is low and the quality is generally poor because gardeners lack improved varieties and information about how to cultivate vegetables. Better technology is one of many factors required to increase the contribution of home gardens to family diets. Much more could be done to educate the public about the advantages of home gardening.

AVRDC will increase its research on home gardens, to broaden the number of vegetable species available, to improve cultural practices including production of seeds and planting material, and to demonstrate the usefulness of home gardening as a means of improving nutrition, particularly among low-income consumers. The underlying economic, sociological and institutional considerations influencing adoption of home gardens will be carefully assessed. A systems approach will be followed with a view to initiating multidisciplinary research, and working closely with NGOs and government agencies that are involved in promoting home gardens.

Postharvest problems

Postharvest handling and marketing are the final links in providing incentives for increased vegetable production. Causes of losses in postharvest handling, storage and distribution need to be identified and their magnitude quantified. There is a need for studies aimed at a better understanding of marketing systems and opportunities and to develop mechanisms for translating theory into practice. Research on postharvest handling and marketing is important to preserving the high quality of vegetables and completing the chain of information necessary for a successful production program.

AVRDC will add appropriate expertise to its staff, and carry out research on postharvest handling and marketing. Emphasis will be on handling, packaging, storage and farm level processing. There is a lot of experience in these areas in the developed countries but they would require adaptation to developing country conditions. Research will be conducted in close collaboration with organizations in the private sector, with national laboratories in partner countries and with other programs, such as the one on postharvest problems sponsored by the Australian Centre for International Agricultural Research (ACIAR) in Asia.

Information Services

Scientific and technical information on vegetables in the tropics is relatively limited. With the exception of that distributed by AVRDC, the information that is available is often informally published, of uneven quality, and widely scattered in different countries, sources and languages. It is generally difficult for researchers in developing countries to obtain access to source material, because of cost, lack of foreign exchange, and the lack of adequate central facilities.

AVRDC acts both as a clearinghouse and a distribution point for technical literature on vegetable research published throughout the world. It also acts as a publisher and distributor of research results of AVRDC and collaborating scientists. Currently, the Center maintains an information program called Tropical Vegetable Information Service (TVIS) which provides limited information to partners in national research systems.

AVRDC will strengthen its efforts through TVIS to provide information on research results, problems and methodologies, to scientists and extension workers in developing countries. Library services will ensure that vegetable researchers gain access to up-to-date information relevant to their work, by means of appropriate retrieval services. AVRDC will also act as a publisher

for scientific material and current information on vegetable research and development, for circulation to cooperating scientists and extension workers. The Center and its partners will identify the most important gaps in published information and take steps to fill them. The possibilities of publishing in languages other than English, by copublication, for example, will be actively explored.

In addition, AVRDC plans to initiate a modest effort to inform donors, policymakers, administrators and the general public, of the importance of vegetables in the developing world and the need for sound policies to encourage their production. The payoff from research, and the need for adequate financial support for research and related activities, will be emphasized, and AVRDC's objectives, programs and approaches will be explained. Press releases for local and international audiences will be streamlined, and liaison with the media strengthened.

AVRDC will continue to provide support for conferences, symposia and workshops, including limited interpretation and translation services. The Center will bring together policymakers and research managers, as well as leading researchers, from countries within a region, to review research policy and progress in vegetable production, and to plan future research. For each of the principal crops, either problem-oriented or state-of-the-art review conferences will be organized periodically.

Training

Lack of trained personnel is a persistent problem in national research systems. It is particularly acute in horticulture. Except for some of the larger national research systems in Asia and Latin America, there are very few national programs that can identify national scientists who work full-time on vegetables. Consequently, there are difficulties in finding staff members in national programs who can collaborate with international scientists in vegetable improvement, or research on production systems. AVRDC therefore recognizes the very important role it can play in the development of human resources for vegetable research and, to some extent, for extension, both through its training programs and through the development of training materials.

Currently, AVRDC provides training in research and production, as well as arranges courses for special purposes. For its research training, it accepts young and middle-level researchers from national systems, as interns or fellows, for periods ranging from a few weeks to several months. They are assigned to individual scientists and projects and gain practical research experience. The Center likewise accepts research scholars from degree-granting institutions to undertake thesis research on problems of mutual interest under joint academic supervision.



Courses in production training usually last for five months and are offered both at headquarters and at the AVRDC Regional Training Program in Thailand. Participants, who may be extension workers or production specialists, spend approximately one-third of their time in the classroom and the remainder on practical applications. The aim is that they should become competent to train other trainers.

In its special-purpose training, AVRDC offers flexible programs to individuals or groups, which may be oriented towards research, extension, or both, and may last from a few days to a few months. Such training may be conducted at the Center or with one of our partner institutions. Each special training program is considered in relation to AVRDC's objectives, as well as to the participant's future role.

AVRDC will continue to give training for special purposes and to emphasize both research and production training to reflect its role in research and its links with development. In future, however, headquarters will concentrate on research training, and much of the production training will be moved to the regional programs, where it can be more closely adapted to local needs. At headquarters the current training program in research will be continued, giving special emphasis to training on new techniques in crop improvement, production systems, germplasm management, integrated pest management, seed technology and information services.

In its contribution to training extension workers, AVRDC will concentrate on training trainers. Training will be directed towards selected national agricultural research systems so that critical masses of subject matter specialists and trainers can be organized at strategic locations. Training will be multidisciplinary, emphasizing the interdependence between research and extension, and encouraging the exchange of knowledge among extension workers and with farmers. AVRDC will encourage national programs that have critical masses of trainers to mount their own national training programs, and will provide specialist assistance to help them to do so. AVRDC will develop training materials both for direct use and for adaptation by national trainers. In response to demands from national programs, training in seed production, marketing and postharvest practices will be strengthened.

In addition, AVRDC proposes to institute a new training course for senior extension administrators and promising researchers who are destined to assume important roles in research and industry. The course will stress the forward and backward linkages of the

vegetable industry and the economic, social and political implications. The course will take advantage of the unique opportunities in Taiwan to highlight the diverse facets of a modern vegetable industry, including seed production, pesticide monitoring and regulation, processing, finance, marketing, exports and farmer organizations.

Collaborative Research, Technology Transfer and Institution Building

AVRDC's research and training programs, as well as its information services, are closely linked to its delivery system which, in turn, is built around its cooperative activities. Collaborative research, technology transfer and institution building are mutually reinforcing activities. All are enhanced by AVRDC's regional and country programs, and through its participation in networks.

Regional programs

The regional programs will be based in those national or regional institutions that have adequate staff and facilities, are strategically located, and willing to host the regional staff and operations. The regional programs are not expected to require substantial additions to capital investment, but there will be a need to fund modest supplementary facilities.

In all of its regional work, AVRDC will collaborate not only with national and regional institutions, but also with other international organizations working in the same region. AVRDC has noted the changing strategy of the CGIAR Centers and the proposed intercenter collaboration on ecoregional activities, especially in the context of working closely with national programs on research of common interest, such as resource management and production systems. AVRDC will seek opportunities for collaboration with other international centers to generate coherent ecoregional programs on problems directly related to its goal.

Asia

In Asia, the AVRDC regional program will be based in Thailand at Kasetsart University, where the Center has been running a regional training center, jointly with the University, for almost a decade. The regional training center will be upgraded to become the AVRDC Regional Program, which will encompass not only training, but also collaborative research, germplasm activities and information services. It will continue to receive trainees from Mainland China, Vietnam, Laos, Kampuchea, Myanmar and the South Asian countries.

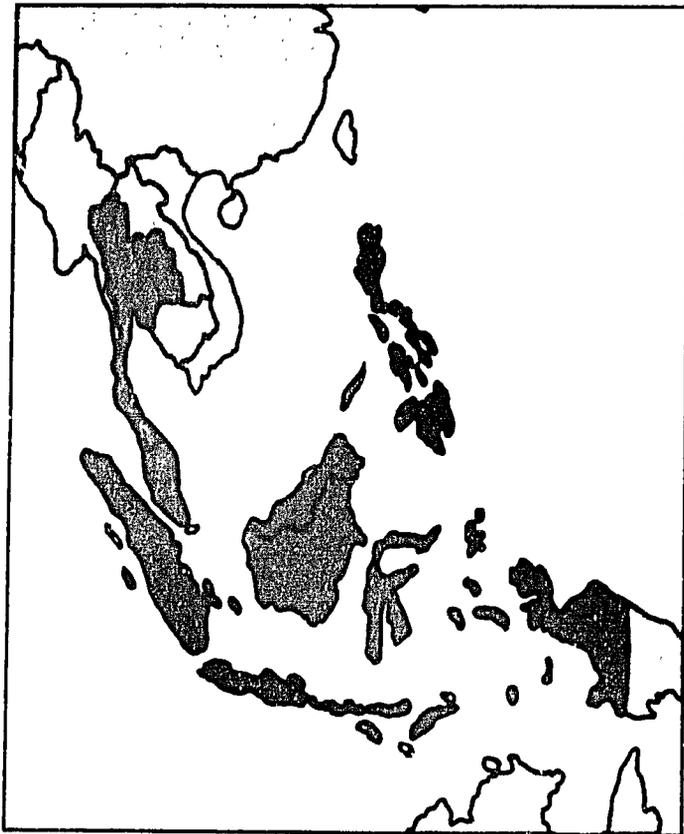


Fig. 1. The Southeast Asian vegetable research network – AVNET.

The Asian regional program will coordinate a network in each of the three subregions: Southeast Asia, South Asia and China. In Southeast Asia, the present network (AVNET) (Fig. 1) involves the ASEAN countries of Indonesia, Malaysia, the Philippines and Thailand. In view of the very similar environments and problems encountered in Vietnam, Laos, Kampuchea, Myanmar and the Pacific countries, a lot of spinoff is expected from AVNET to these other countries, which have as yet very limited research capacity in vegetable crops. AVRDC plans to integrate the activities with these other countries gradually into AVNET.

In South Asia, six countries (Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka) have already organized themselves into a regional network called SAVERNET, and have invited AVRDC to be their executing agency. The Center is mobilizing international support for the network and plans to have the network in place as soon as possible. AVRDC, through its program based in Thailand, has signed bilateral agreements with Bangladesh, Bhutan, Pakistan and Sri Lanka.

In view of its size and diversity, Mainland China is considered by AVRDC to be a separate subregion in its own right. AVRDC has been actively working with Mainland China since 1981. Its needs and research challenges are great and the linkage has already been very fruitful. AVRDC proposes to further strengthen its collaboration with Mainland China, and in time establish a liaison office in Beijing. With the concurrence of the national research system, AVRDC will assist in the collection of vegetable germplasm jointly with IBPGR and FAO.

Sub-Saharan Africa

Based on the experience of other IARCs, AVRDC is initially regarding sub-Saharan Africa (SSA) as consisting of three subregions: Southern Africa, Eastern/Central Africa and West Africa. AVRDC has begun its activities in SSA through collaboration with SACCAR in a regional network in Southern Africa. AVRDC has been asked to be the executing agency of this network, known by the acronym CONVERDS (Fig. 2). From its base in this Southern African network, AVRDC can reach out to East and Central African countries with similar environments and commodity preferences.

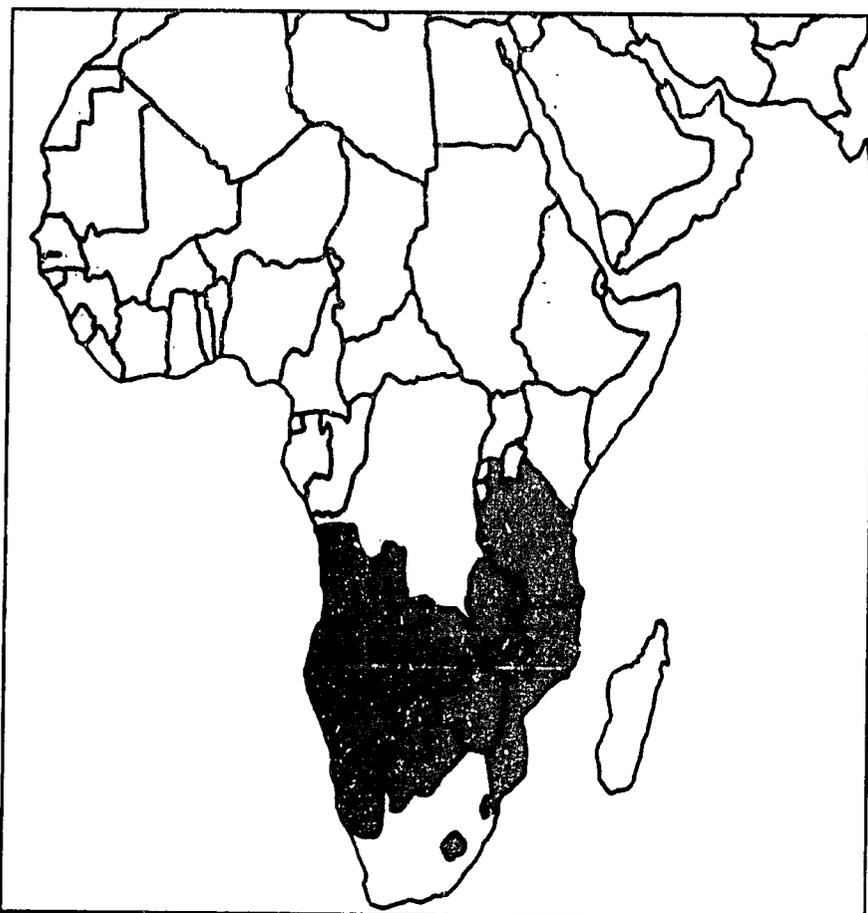


Fig. 2. *The Southern African vegetable research network – CONVERDS.*

AVRDC will step up exchange of germplasm and information more generally with interested African national research systems. It will build up expertise and information on African vegetable production systems by working closely, in the first instance, with at least one national research system in each of the other subregions. It will participate in, or initiate, networks in the other subregions as resources become available.

Latin America and the Caribbean

At least four subregions can be recognized in Latin America and the Caribbean, namely: Central America and the Caribbean, tropical South America, the Andean region and the Southern region. In each subregion, there are active national programs in vegetables, as well as interested regional and international institutions, such as IICA, CATIE, CARDI, CIAT and CIP. As a first task, AVRDC in close collaboration with IICA will propose to bring together, by way of consultation workshops, the key institutions to assess needs, priorities and directions, and preferred modes of collaboration.

Initially, AVRDC plans to revive its moribund agreements with IICA, CATIE and CARDI and to become directly involved in Central America and the Caribbean. The environment in this subregion is closely homologous with the environment in Southeast Asia where AVRDC has been most active. Consequently, the prospects for the transfer of relevant experience will be high. As a first step, AVRDC plans, in partnership with IICA, to place a liaison scientist in an appropriate institution, to coordinate AVRDC's activities in germplasm and information exchange. Research networks, administered by IICA, already exist in the other LAC subregions. Vegetables can be incorporated as one of the commodities in these networks as resources become available.

West Asia and North Africa

AVRDC's ability to respond to the needs of the WANA region is currently limited by the sharp differences between the humid tropical ecosystems of its Asian base and the Mediterranean climate of the major vegetable growing areas in the region. Nevertheless, previous experiences suggest that AVRDC germplasm developed for heat tolerance and resistance to certain pests and diseases has value for some national programs in the WANA region.

The Center will continue to exchange germplasm with interested national programs and open up possibilities for training and scientific exchange. As resources become available, it plans to post a liaison scientist to work with a key national research system in the region to establish a base for wider operations. As a next step, AVRDC would help to establish a network in each of the two subregions.

Country programs

In response to specific requests from individual governments, AVRDC will collaborate with national vegetable programs in a bilateral mode, focusing on research and institution building. Country programs will be administered by their respective regional offices and given additional technical support from headquarters. Generally, the country programs will be supported, as at present, by specific grants from donor agencies. Each country program will involve a short-term to medium-term commitment on the part of AVRDC and the deployment, at least for an initial period, of a resident scientist. Currently, AVRDC has country programs in Indonesia, the Republic of Korea, Malaysia, the Philippines, Taiwan, Thailand and Bangladesh.

Looking to the future, AVRDC will:

- continue current programs in Southeast Asia, Taiwan, Korea and Bangladesh;
- initiate country programs, as funding permits, in selected South Asian countries such as Pakistan, Sri Lanka, Nepal and Bhutan; and in Indochina;
- consider establishing country programs in each of the major subregions of SSA, as well as in the LAC and WANA regions.

Monitoring AVRDC's Achievements

If AVRDC is to continue to operate, its aims must be supported by the countries with which it collaborates. Its ultimate target groups are small-scale farmers and low-income consumers. However, AVRDC does not deal directly with farmers and consumers. It deals with researchers and extension workers who, in turn, deal with farmers. The countries will continue to encourage their researchers and extension workers to collaborate with AVRDC only so long as the end result is consistent with their own development objectives.

The main objectives of the Center are to increase income and improve nutrition among the poor while maintaining, if not enhancing, the environment. Progress towards these goals which AVRDC shares with its partners is difficult to measure and even more difficult to ascribe directly to the work of AVRDC. Increasingly, however, methodologies are being devised to come to grips with these problems. Accordingly, in addition to the usual measures of achievement, such as the number of varieties released, the number of improved management practices recommended, the number of publications produced and the numbers of researchers and specialists trained, AVRDC will keep abreast of developments in methodology in order to assess and make more transparent the impact of its activities.

More specifically AVRDC will monitor its achievements using specific criteria, related to progress in its partner countries and with respect to its designated principal and regional crops. These criteria will be kept under review but, initially, will include assessments of the extent to which AVRDC has contributed to:

- the building of vegetable germplasm collections characterized and evaluated for important traits, documented, cleaned up, preserved and made available to interested organizations and researchers;
- the adoption of improved vegetable varieties with high yield, resistance or tolerance to significant biotic and abiotic stresses, good quality, and high acceptability to producers and consumers and their impact on farmers' incomes and production;
- adoption of soils and other resource-conserving practices;
- adoption of effective integrated pest management practices for major pests and reduction in the use of pesticides;
- adoption of efficient handling and marketing practices and reduction of wastage;
- the extent and productivity of home gardens, and their impact on nutrition, especially of low-income families;
- the provision of a dependable supply of high-quality vegetable seeds, provided by public institutions, the private sector, or both;

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- the identification of further sources of adaptive traits, resistance, or tolerance, and the development of effective screening techniques in the improvement of the Center crops;
 - the adoption by national researchers of modern biotechnologies and their impact on research effectiveness;
 - ready availability of scientific and technical information on vegetable production and marketing; and
 - the adequacy of trained research and extension personnel for vegetable production.

Implementation

This strategic plan envisages a significant expansion of AVRDC's activities in terms of its coverage of regions, commodities and areas of research. To accommodate these changes, the present centralized structure will shift to a more decentralized and collaborative mode, based on regional networks and extended links with advanced research laboratories. The basically discipline-oriented structure at headquarters will be retained, however, as a critical mass of research capacity.

The new regional programs will bring AVRDC closer to its partners, make fuller use of existing capacity in the more mature national research systems, and boost the Center's contribution to building national capabilities. They will also provide greater opportunities for donor funding, through restricted core activities and special projects.

In developing its regional activities, AVRDC attaches great importance to the proposed subregional networks. For each network, the objectives will be defined by the participating national programs. Each will be guided by a steering committee and there will be regular meetings with the participating scientists to identify goals and monitor progress. The networks will be organized on the understanding that responsibilities will be shared, and that there will be free interchange of germplasm, information and results among all participants.

Organization

AVRDC's proposed organizational structure is shown in Figure 3. Center policy will be determined by a Board of Trustees composed of outstanding individuals drawn from a range of disciplines and professional backgrounds in developing and developed countries, and from different regions of the world. Administrative responsibility will be vested in a Director General, accountable to the Board of Trustees, and assisted by two Deputy Directors General. One will be responsible for research and international cooperation, and, the other, for finance, administration and research support services. The Director General and the two deputies will be full-time administrators and will function as the senior management team.

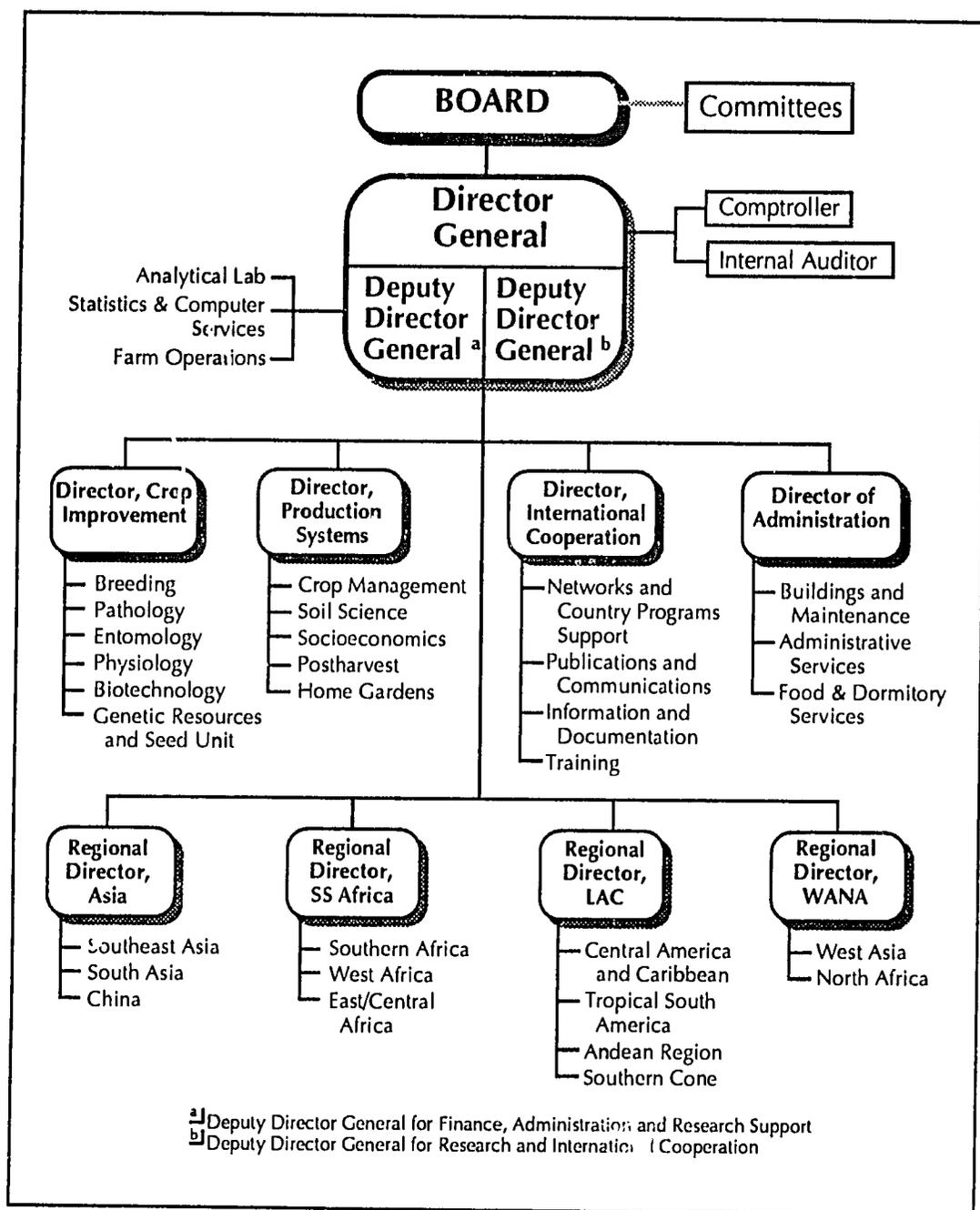


Fig.3. Proposed AVRDC organization chart.

Programs at headquarters will be planned and implemented by three departments:

- **crop improvement**, consisting of units for breeding, pathology, entomology, physiology, biotechnology, genetic resources and seed technology;

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- **production systems**, consisting of units for crop management, soil science, socioeconomics, postharvest handling and distribution, and home gardens;
 - **international cooperation**, giving technical support to the regional and country programs and networks, and consisting of units for information and documentation, publications and communication, and training.

Each department will be led by a director, who will provide overall leadership in setting program direction and priorities and in managing staff, finance and other resources; be responsible for preparation of work plans and budgets of projects within respective departments; monitor and evaluate implementation of projects; and assist in senior staff recruitment and performance evaluation.

A project management system will be adopted for all activities. Generally, the projects will be multidisciplinary and include staff from different departments or units. Project leaders will plan, coordinate and monitor activities. Projects may cut across departments, but every project will be assigned to a department for purposes of monitoring and coordination.

In addition, a coordinator will be assigned to activities relating to each principal and regional commodity and to home gardens. Each coordinator will provide an overview, monitor progress, and advise management on priorities, directions, strategies and the balance of activities required.

The four regional programs will coordinate and provide support for the subregional networks, as indicated in Figure 3. Each regional program will be led by a regional director, reporting to the Director General. Activities in the regional programs will be included in the project management system, and will be built around small multidisciplinary teams of core staff. The composition of each team will be flexible and will be determined partly by the problems to be tackled and partly by the expertise available in the national programs.

Decentralization and expansion of the commodity coverage will condition the division of functions between the headquarters units and the regional programs. Headquarters will:

- assume primary responsibility for principal crops;
- shift towards more strategic research, and provide disciplinary inputs and other backstopping to the regional programs;

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- shift the emphasis in training towards special research skills, senior research managers and degree-oriented training, and to socioeconomics, seed technology and postharvest handling; and
 - provide information services.

The Regional Programs will:

- assume primary responsibility for regional crops and production systems, and conduct applied and adaptive research, and occasionally strategic research, on regional problems of high priority;
- link regional programs with activities at headquarters and elsewhere and provide feedback for program planning;
- coordinate the networks, and provide them with scientific, administrative and logistical support;
- conduct training, giving emphasis to production training, the development of training information and materials, and translation to local languages; and
- administer the country programs in their respective regions.

Collaboration with Other Institutions

AVRDC's vision of the future is heavily dependent on collaborative relationships among a wide range of institutions. For many national research systems, the only way they can multiply their efforts is by pooling their expertise and sharing their results in a network. AVRDC will take every opportunity to mobilize and harness the capabilities of partner national programs to exploit synergy and complementation and avoid unnecessary duplication.

AVRDC has special opportunities for collaboration with other international agricultural research centers. For example, it will seek opportunities for collaboration with IRRI (International Rice Research Institute) and ICRISAT on cropping systems in Asia; with IITA on soybean and cowpea and on cropping systems in Africa; with CIAT on snap bean and soybean and on cropping systems in Latin America and the Caribbean; with IBPGR on germplasm collection and documentation; with ISNAR (International Service for National Agricultural Research) on research management; and with IFPRI (International Food Policy Research Institute) on economic analysis and policy research.

AVRDC will also strengthen its relationships with regional organizations. It will collaborate with CGPRT (Regional Coordination Center for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific) in South Asia, Southeast Asia and the Pacific on vegetable and grain legumes. It will continue to collaborate with SACCAR in Southern Africa and will explore the possibilities for collaborating with SAFGRAD (Consultative Advisory Committee for Semi-Arid Food Grain Research and Development), INSAH (l'Institut du Sahel) and CORAF (Conférence des Responsables de la Recherche Agronomique Africains) in other parts of Africa. It will expand its collaboration with IICA in Latin America and the Caribbean, and work with CARDI and CATIE on applied research in the Caribbean and Central America.

Opportunities for collaboration with the private sector will also be actively pursued, especially in biotechnology, seed technology, postharvest handling and marketing. AVRDC attaches particular importance to strengthening its capacity in strategic research by increasing its collaboration with advanced research laboratories, whether belonging to the public or private sector, and whether in the developing or developed countries. Such collaboration provides access to expertise in the rapidly advancing frontiers of knowledge in important areas of science, such as molecular biology, as well as providing opportunities for familiarization with sophisticated techniques and equipment. Finally, AVRDC will widen its collaboration with organizations interested in the collection and storage of vegetable germplasm.

Resource Implications

Senior Staff and Operating Requirements

Senior staff

At the minimum, the senior core staff of the Center is proposed to increase from the current 21 to 44 posts (Fig. 4).

The plan assumes that the present number and mix of disciplines at headquarters is just about the critical mass required to address the needs of the proposed set of principal commodities as well as to provide scientific and administrative backstopping to the regional programs. Thus, the senior core posts at headquarters will only slightly increase with a net addition of three posts, one of which is a second deputy director general post.

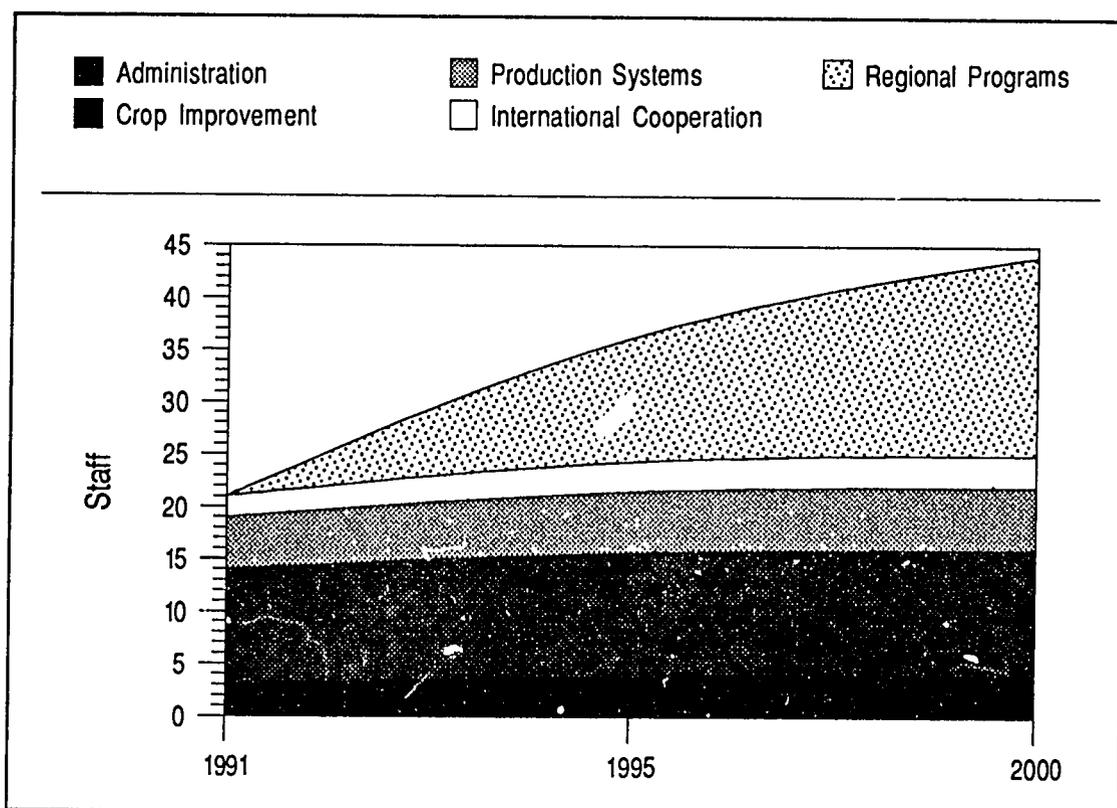


Fig. 4. Senior staff positions.

Most of the increase in core senior staff positions will be in the establishment of the regional programs (a total of 19 new posts at the end of the plan period). There will be 4, 8, 4 and 3 senior posts in Asia, Sub-Saharan Africa, Latin America and the Caribbean, and in the WANA region, respectively.

There will be only four core regional scientists in Asia, partly because the region's needs are served from headquarters and, partly in recognition of the capability of a number of national programs in Asia.

The relatively small number of proposed core senior posts at headquarters and in the regional programs will be complemented by a number of scientists who will be supported by special projects. Under this category are scientists who will temporarily provide support to the regional networks until such time as the participating countries are able to assign national scientists to operate the networks themselves, as well as those seconded as liaison scientists in the country programs. Additional scientists will also be hired to work on urgent research problems which require a momentary concentration of effort beyond those that can be provided by the core staff at headquarters.

Operating requirements

The core operating budget is planned to increase from the present level of about US\$8.0 million to about US\$17.0 million by the year 2000, at current values. The allocation for the regional programs will increase from zero to 34% at the end of the plan (Fig. 5). The three program departments budgets will decline from 61 to 42% while that for administration and general operations will moderate from the present level of 29 to 18% by the year 2000.

Capital Costs

Facilities at headquarters in Taiwan are very modest. They were built early in the 1970s and the Center has outgrown them. Several improvements in physical facilities will be needed, including:

- a new laboratory building at headquarters to relieve congestion in the existing laboratory, and to accommodate a new biotechnology facility and postharvest research unit;
- conversion of part of the existing laboratory building into a training and research support services center;
- a new wing of the hostel and some additional residences;

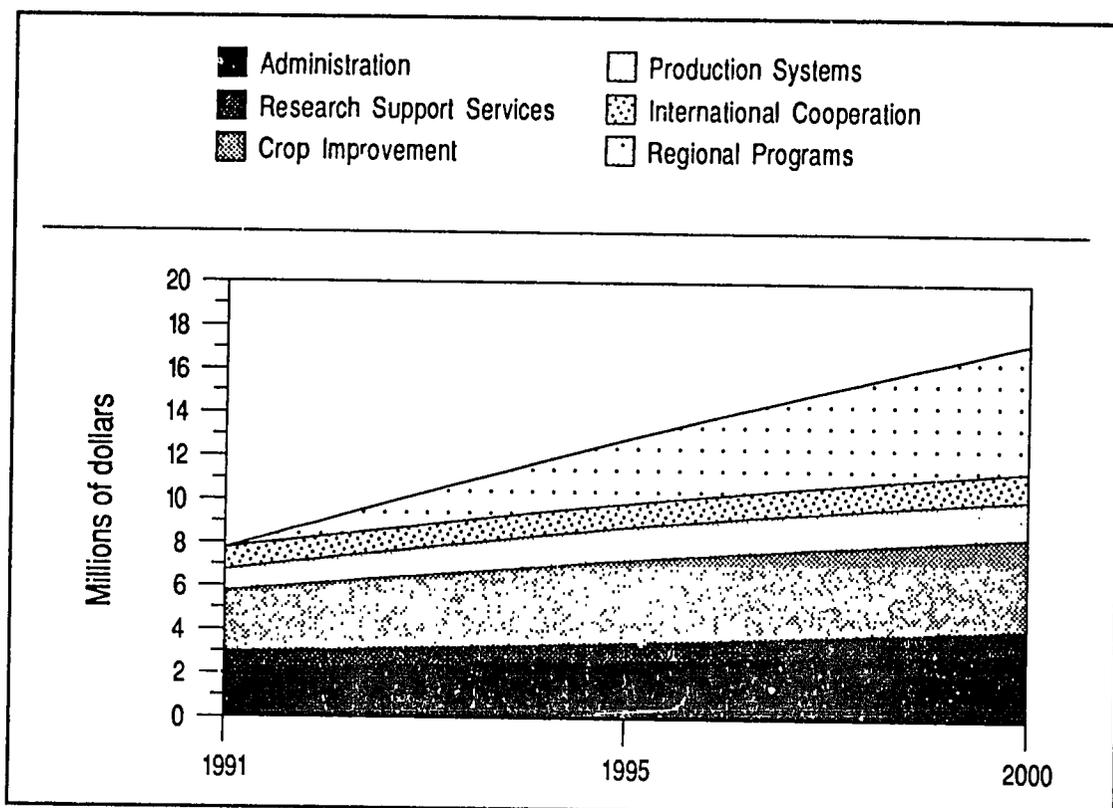


Fig. 5. Operating requirements, 1991-2000.

- additional greenhouses, a headhouse and an annex service building.

The basic facilities at the AVRDC Regional Program at the Kamphaeng Saen campus of Kasetsart University, which is about 80 kilometers from Bangkok, are provided by the University. Some additional facilities have been built with special funds over the years. In addition, AVRDC will have to build:

- five residences for senior staff;
- a small annex of greenhouses and screenhouses and a headhouse.

The other regional programs are expected to share facilities with the national or regional institutions which are hosting them. Nevertheless, AVRDC should plan to provide supplementary capital for additional facilities for its own use. In total, capital requirements will amount to about US\$12.0 million.

Sources of Funding

In addition to capital requirements, projected core funding will increase by about US\$1.0 million per year over the next 10 years. To meet these requirements, AVRDC is approaching the host government for support for the new facilities at headquarters and is undertaking steps to expand its donor base. It will mount a professional campaign to make new donors aware of its track record and potential to contribute to the needs of developing countries. At the same time, the Center needs to encourage its present donors to increase their contributions.

Among the international agricultural research centers, AVRDC is probably the only one that receives the greater part of its core budget from developing countries. The international research community and the international donor community, through their deliberations in the CGIAR and its Technical Advisory Committee, have recognized the importance of vegetables to developing countries and have, on at least three occasions, called for an international initiative on vegetable research and development. In its 18 years of existence, AVRDC has demonstrated what it can do in Asia, particularly in Southeast Asia, with relatively limited resources. It is now ready and willing to assume a larger role as a global institution.