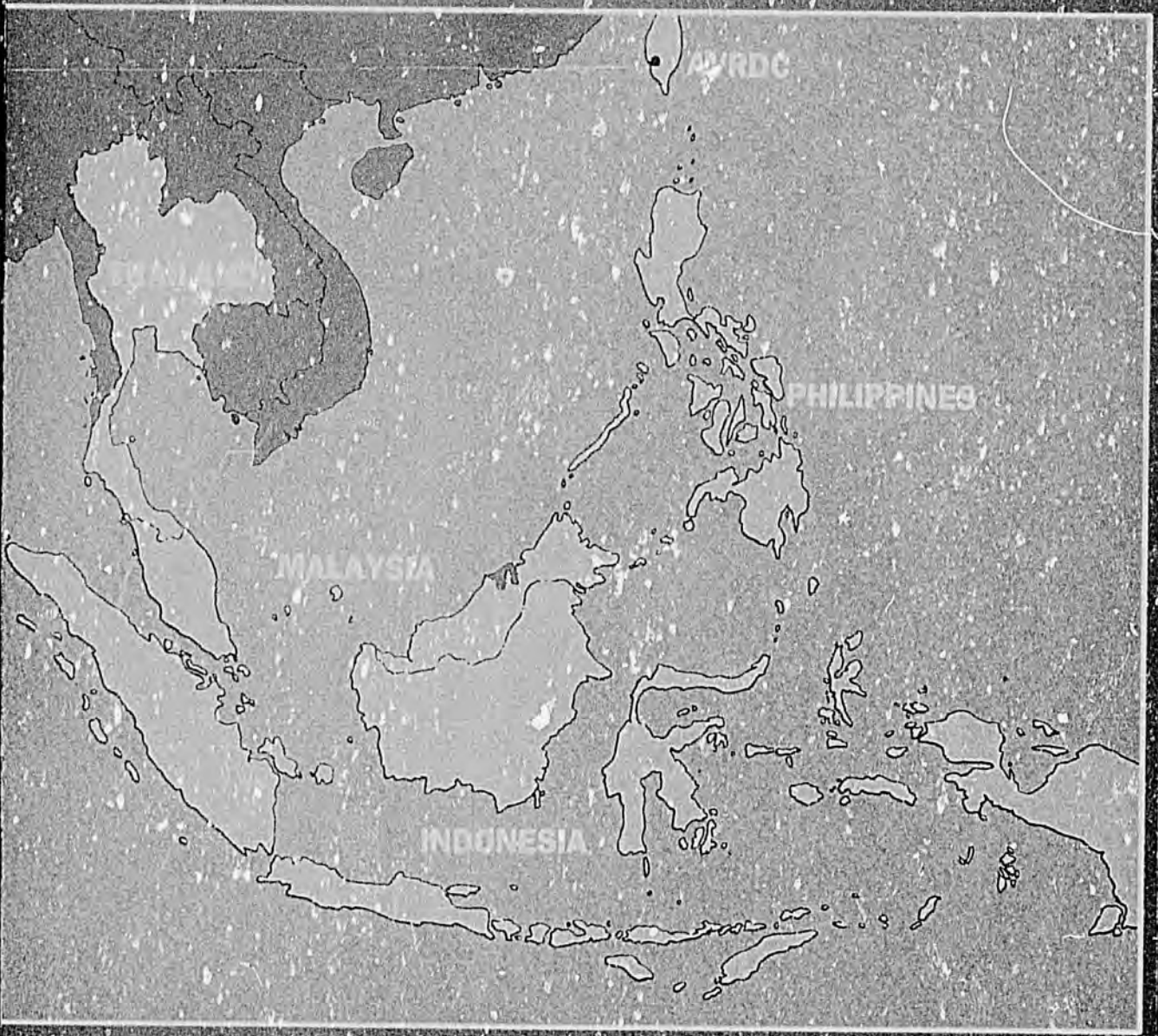
VEGETABLE RESEARCH IN SOUTHEAST ASIA



Asian Vegetable Research and Development Center

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Vegetable Research in Southeast Asia

AVRDC-ADB Workshop on Collaborative
Vegetable Research in Southeast Asia
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Acknowledgments are in order to the dedicated AVRDC staff who have somehow found time to fit in the work required to prepare this Proceedings. The significance of this accomplishment is indicated by the fact that this Proceedings has been prepared and published in barely four months from conclusion of the workshop.

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The authors of the papers in this Proceedings are to be congratulated for preparing their papers in the limited time available and for sharing their time in rapidly reviewing them on two separate occasions each. The Workshop Coordinator, Dr. Romeo T. Opeña, has always found time to help find solutions for substantive questions as they arose during the preparation of this volume. Finally, the Asian Development Bank is to be thanked for providing AVRDC with the resources to hold this important Workshop and to publish and distribute this volume. Dr. Nihal Amerasinghe, Senior Sector Planning Specialist at the Asian Development Bank is recognized for his assistance at all stages in the formulation and implementation of the Workshop and providing sustained motivation to prepare this Proceedings in record time.

Welcome Address

George A. Marlowe
Director General
Asian Vegetable Research and Development Center, P.O. Box 205, Taipei 10099

On behalf of the entire staff of the Asian Vegetable Research and Development Center (AVRDC) I extend to each of you our warmest welcome to this very important Workshop. We hope you will be comfortable We hope you will enjoy the good food in Taiwan and get lots of rest, because we have a great deal of work to do in this coming week.

This Workshop provides a valuable opportunity for all of us to share our problems; increase our understanding of the region; and development pathways for collaborative problem solving and technology transfer. Each group has a personality of its own. Already one can sense that this group is an open, congenial and concerned group.

We have in this room a significant collection of experienced and dedicated workers of great capability. It is hoped and expected that this Workshop will be able to duly record the current status of vegetable development in Southeast Asia; the problems constraining its research potential; and assess the manpower and resource base from which realistic planning can develop.

I would like to introduce the two key persons at the head table who have contributed so much to the realization of this Workshop. We are deeply appreciative of the significant financial support and encouragement provided by Director Soeksmono B. Martokoesomo and Dr. Nihal Amerasinghe, Senior Sector Planning Specialist, Agriculture Department (West) of the Asian Development Bank. We are grateful for the encouragement and assistance injected by Dr. Paul C. Ma, Chairman of the Board of Directors of the AVRDC. On my right I would like to introduce our former Deputy Director General, Dr. Paul M.H. Sun who has been very recently appointed as Commissioner of the Provincial Dept. of Agriculture and Forestry. Very shortly we will ask Dr. Sun to say a few words to the group.

I wish to introduce the very hard working committee who helped to put this workshop together. Dr. Romeo T. Opeña, Director of our Crop Improvement Program served as Executive Chairman. Mr. Michael Chin, Director of Administration has been responsible for your many arrangements of housing, travel, etc. Mr. Bruce T. McLean, Head of Information Services, has been responsible for the many facets of publication preparation. Mr. Diosdado Castro, Head of our Training Office, was responsible for meeting room preparation and audiovisual facilities. Serving the broad range of activities of the program were Drs. N.S. Talekar, Paul M.H Sun, S. Shanmugasundaram, and Samson C.S. Tsou.

We are all looking forward to our fruitful week together. We hope those of you who have been to AVRDC before will enjoy renewing acquaintances. For those of you who are making your first visit to AVRDC we hope you will feel a part of the family spirit and dedication to service for which this Center is well known.

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Opening Remarks

Soeksmono B. Martokoesoemo

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Director General of AVRDC, Directors General and Directors of Agricultural Research of the Governments of Indonesia, Malaysia, the Philippines and Thailand, Distinguished Delegates, Ladies and Gentlemen:

I am privileged to have the opportunity of addressing this opening session of the Workshop to Establish a Collaborative Vegetable Research Program in Southeast Asia. I am indeed honored to be here and would like to convey to you the greetings and cordial good wishes of my colleagues at the Bank on this important occasion. The Asian Development Bank is happy to sponsor this strategy planning workshop for vegetable research scientists and research policymakers from four of the Bank's member countries — **Indonesia**, **Malaysia**, the **Philippines** and **Thailand**. We are grateful to all of you for having accepted our invitation to devote your precious time and incomparable experience to contribute to this important Workshop.

I would like to take this opportunity to give you some insights into the Bank's involvement in the agriculture sector in the region and in particular its support for agricultural research. I would also like to indicate to you the Bank's perception and expectations from the Workshop.

Agricultural development has always been an important concern of the Bank. Over the period 1967-87, the Bank's total lending to the agriculture sector amounted to about US$7.0 billion, which is about 32% of Bank lending amounting to US$22.1 billion. The Bank recognizes the need to support agricultural research and has funded such activities on a selective basis at the project, national, regional and international levels. During the period 1967-87, the Bank's total support for agricultural research and extension has amounted to US$313 million or 4.5% of its agricultural lending. We believe that, given the current resource constraints, volatile economic climate and rapidly changing needs of the region, the future development of agriculture would largely depend on the technological breakthroughs generated by research. There is also increasing recognition that future economic growth and development would come from a science-based, rather than a resource-based, strategy.

The countries of Asia have made impressive advances in the production of rice and wheat over the last two decades. Rice and wheat are the major sources of calories (and often protein); the plentiful supply of which has minimized the possibility of famine in all but a few isolated areas of the region. However, many people in the region die prematurely because of diseases related to malnutrition and millions suffer ill-health from dietary deficiencies. Malnutrition is caused by several factors but the shortage in the supply of vegetables, which are an indispensable part of the human diet as an important source of vitamins and minerals, has been a major cause. The availability of vegetables in Asian countries is low. In the past, production and research have been largely concerned with cereals and plantation crops, while vegetables have been neglected. The situation is changing as many of the countries, especially in Southeast Asia, have more or less reached self-sufficiency in staple foods and are now placing more emphasis on the production and research of nutritive food crops.

AVRDC was established following the signing of an agreement in 1968 by Japan, the Republic of Korea, the Philippines, Thailand, the United States of America, Vietnam, Taipei, China and the Bank, to undertake research on improving the production of protein-, vitamin-,

and mineral-rich vegetables. The Bank's first technical assistance to an international center was to AVRDC to establish its physical facilities and experimental farm. It is our view that during the past two decades, AVRDC has made good progress towards achieving its goals. Advance lines of all its principal crops are being effectively tested in national programs throughout Asia and the Pacific region and many have been released as named varieties in the Bank's member countries. AVRDC has also acquired a reputation of being a well-managed international research center and has been commended for its contributions to development and the quality of its research work and is recognized as a center of excellence.

We believe that the national agricultural research systems, especially in Southeast Asia, have benefited by AVRDC's improved vegetable production technology and training. The Bank has provided technical assistance support to AVRDC to establish outreach activities in: Indonesia, the Republic of Korea, Malaysia, the Philippines and Thailand. The reason for the Bank's focus in supporting vegetable research in Southeast Asia has been the satisfactory level of basic staples in these countries and the national interests on the production of high-value crops such as vegetables. AVRDC's bilateral programs, largely initiated and supported from Bank funds, have involved aspects of training, information dissemination through direct contacts and the conduct of symposia and workshops, and collaborative germplasm evaluation. In this regard we look forward to the findings of a study commissioned in conjunction with this Workshop which will be presented by a consultant on the impact of the outreach activities.

AVRDC has now been in existence for almost two decades and it is time for stock-taking. The ideal role of an international research center should be one that is supportive, rather than competitive, with the goals of the national agricultural systems. AVRDC's research strategy so far in generating new technology has heavily favored the problem-oriented, applied research approach. Until recently the principal goal of the Asia-Pacific regions NARS, especially in Southeast Asia, was self-sufficiency in staple crops and interest in vegetables was comparatively low. Against this background we believe that the ongoing strategy followed by AVRDC to emphasize applied research was well justified. However, with the refocusing of national interests in Southeast Asian countries on high-value crops like vegetables, transfer of improved vegetable production technology, and the improvement of research manpower capability, would warrant a reexamination of the roles of a technology-producing institution like AVRDC and the NARS both individually and collectively. Research-capable NARS in Southeast Asia could well assume some of the load of applied vegetable research which has hitherto been AVRDC's responsibility.

These concerns would be the subject of discussion at this Workshop. We believe that it is now timely to examine the roles of AVRDC and the NARS in Southeast Asia, individually and collectively. A matter worthy of careful consideration is the proposition that, in the interest of efficiency of resource use and research output, AVRDC should concentrate more of its future efforts on upstream (strategic) research and leave the downstream (applied and adaptive) research to the NARS. Another consideration is the possibility of setting-up a formal vegetable research network among Southeast Asian countries which, share a common environmental profile, have similar biotic (pests and diseases) and abiotic (soil and climate) stresses, and relatively well developed institutional capability to spread the workload. Such collaboration could have several advantages, in the main, avoidance of duplication and the sharing of resources. These possibilities need to be fully examined in the interests of optimizing the use of scarce resources and promotion of research of relevance to the region. These matters will need to be fully discussed and recommendations made based on your deliberations at this Workshop.

Mr. Chairman, it is the Bank's expectation that this Workshop which brings together high-level research policymakers and leading vegetable research scientists from Southeast Asia will help to: define the current state of the art for vegetable research; identify gaps in vegetable research; indicate the availability of technical manpower and facilities; establish priorities for vegetable research in the region; develop a collaborative program of work with judicious allocation of responsibilities among NARS based on existing manpower levels and skills, including considerations of sharing of facilities, expert consultations, information and germplasm exchanges; delineate future research roles of AVRDC vis-à-vis NARS; and formulate a collaborative

vegetable research program for Southeast Asia. The Bank perceives this Workshop as an important step in strengthening research on vegetables in Southeast Asia in a systematic way and looks forward to your recommendations for appropriate follow-up action. We expect that the publication of the proceedings of this Workshop, which has brought together a group of talented scientists and experienced research policymakers, will indeed be a valuable output for the Bank and other interested donors on the current situation, outlook and identification of priorities for vegetable research in Southeast Asia.

In conclusion I would like to congratulate the Director General of AVRDC and staff for the excellent arrangements which have been made for this meeting and my thanks for your special attention to make my visit pleasant and memorable. I would also like to wish you all a pleasant stay and hope you will have a fruitful Workshop.

Thank you and good day.

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Conceptual Framework of the Workshop

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Perspectives

The Asian Vegetable Research and Development Center (AVRDC) has been engaged in the improvement of vegetable production for the hot, humid tropics since its inception in 1972. Technological advances in tropically adapted vegetable cultivars and improved practices for vegetable production have been achieved through AVRDC research.

The national agricultural research systems (NARS) in the Southeast Asian region have used AVRDC's improved vegetable production technology. This technology has been transferred to the NARS in the region through various media, such as the ADB-funded bilateral projects in the Philippines, Thailand, the Rep. of Korea, Malaysia and Indonesia; informal collaboration among scientists, training programs at AVRDC and at the Thailand Regional Training Programs; and information transfer through publications.

Relative self-sufficiency in the basic staple food in Southeast Asia has led to a welcome focusing of the NARS' interests on high value crops like vegetables. During the 1980s many countries in the region have developed active programs of degree-oriented manpower development needed for the implementation of their revised national priorities. AVRDC has been a dependable partner of the NARS for manpower development at the technical level; development that is also crucial in effecting a progressive change in the vegetable industry. A good number of national program personnel in the region have successfully completed AVRDC training programs, appreciably strengthening the manpower resource of the NARS in the region over the past decade. Although difficult to measure, the deployment of these skilled personnel in the national vegetable programs has enhanced their research and development capabilities.

Are developments in vegetable research in the region primed for networking? This and other crucial questions on research collaboration will be focal points for discussion and consensus building in this week-long regional workshop.

Vegetable Research in the Developing World — General Reflections

Vegetable production and its attendant problems pathetically predates the national vegetable research programs in the developing world. Despite the importance of vegetables in the human diet and their long history of usage, vegetables have not generally been given the research attention they deserve.

Developing countries usually earmark their limited research budgets on "belly fillers", particularly staple grains, and have largely ignored vegetables. This is understandable since these basic commodities are produced and consumed in large scale and the increase in total food output that may result from an investment in research is correspondingly higher. They are also obviously "political" crops which demand the unwavering attention of the country's policymakers.

Vegetable growers tend to earn higher incomes than most other farmers because of two factors: more intensive land use and the high economic value of vegetables. It is, therefore, common to find that vegetable growers eagerly seek new technology. With this driving force, progressive changes in vegetable production, limited as they may be, have taken place even in an atmosphere of minimal research attention by the national programs. However, as stated

above, most countries in Southeast Asia have been moving to strengthen their current national vegetable research systems.

For a diverse group like vegetables, the list of potentially researchable species is long. In addition, the methods of production and even the uses of a particular vegetable vary from place to place, making the group difficult to manage at the research level. With the limited resources allocated for vegetable research that is common in many developing countries, we may yet continue to see vegetables as a neglected commodity even as the interest and capability in the national vegetable programs progressively increase.

Collaborative Research — The Road to Cost-effective Technology Generation

Research capabilities among the NARS vary considerably. Some NARS have a fairly good balance of manpower across disciplines, whereas others do not. Some have a greater concentration of trained personnel in an area of expertise while they may be lacking in others. The critical mass of scientists needed to develop new knowledge in the broad field of agriculture may not be present in any one national program; therefore, collective joining of resources among the NARS in the region and focusing their work on specific problems through collaborative association appears to be a logical, cost-effective solution. This is especially important in light of the tight funding opportunities for research in recent years.

A collaborative linking of national research systems would allow a broad complementation of the strength and weaknesses of the participating members. In this relationship a country with strength in a particular field could take the lead in technology development for that field while others marshal their resources where they are most strong. The wherewithal of any individual member country could thus be collectively focused to solve the technological problems that its personnel have been trained for and have the experience in. Technical outputs are then shared with other members of the network. There seems to be little doubt that the vegetable research programs in the developing countries of Asia, where there is a long history of vegetable usage, a good concentration of interest, increased level of staffing, and an enhanced quality of research personnel, could benefit from a collaborative research relationship.

Some Fundamental Grounds for Research Networking in the Region

The bases for the establishment of a network must be present before it can be formed. Obviously, the most important consideration is whether there are common strategic interests for all prospective members. Plucknett and Smith (1984) considered that strong self-interest underpins productive networks and that effective networking cannot be mandated. Socioeconomic factors, ethnic affinities, geographical and climatological homology, and other associated effects underlie these common denominators and form the bases of having widely shared problems that motivate participants of the network to contribute effectively.

Countries in the Southeast Asian region have common denominators which may rationalize the establishment of a regional vegetable research linkage. The most obvious of these are as follows:

- **Homology of environment**: Southeast Asian countries share, in large part, a common environmental profile. A hot, humid climate generally typifies the region throughout most of the year. Production systems should be largely transferable within the region.
- **Similarities of production constraints**: The constraints in the production of vegetables in the region are largely the same. For example, production of many vegetables in the region suffers from high temperatures and high rainfall. With few exceptions, the major

diseases and pests of vegetables are similar. Therefore, the systems of vegetable production developed for one country may be adopted in another with minimal changes.

Common vegetable commodities: A good proportion of the vegetables that are grown and consumed in Southeast Asia are the same from country to country. Priorities among NARS may differ; nonetheless, it should not be difficult to find vegetable species which are of common interest to all of the countries in the region and which are, based on common strategic motivations, networkable.

Networking the Region's NARS — the Why and the How's of the Workshop

The title of this workshop cannot belie its primary goal which is to bring together the interests of the national vegetable research programs in Southeast Asia, particularly those of Indonesia, Malaysia, the Philippines and Thailand, into a collaborative relationship. The benefits that would accrue from a mutual association have been discussed above. Plucknett and Smith (1984, 1988) and Davis et al. (1986) treated the subject of payoffs from collaborative research more extensively. Briefly, these benefits are as follows: broader problems or issues are covered by networking; cost-effectiveness of research may be brought about by the sharing of resources, better use of information, and reduced duplication of research; new insights are gained as scientists are exposed to a broader base of relevant information; research methodologies are improved; communication among researchers is enhanced; and, networking leads to more training opportunities, especially in short-term, network-related expertise.

In order to clear the way for a realistic networking of the region's NARS, certain mechanisms have been built into the present workshop: (1) presentation of facts on the state of vegetable research in the region, including a discourse on the vital issues affecting the industry; (2) window casing of model vegetable industries and a successful agricultural research network; (3) development of recommendations for collaborative vegetable research in the region; and (4) the preparation of joint project proposals after the workshop for submission to funding donors as identified by the national programs. These mechanisms are depicted as stepwise procedures in Figure 1 and are elaborated below.

Current Status and Priorities of Vegetable Research in the Region

The first principle of successful networking is predicated on a clear definition of the problems and development of a realistic research agenda (Plucknett and Smith 1984). In order to effectively address this precondition, this workshop will devote a good part of its effort on taking stock of the state of vegetable research in the region. This vital exercise has three components. The first involves an **updating on the status of vegetable research and priorities in the national programs of the region**. In order to obtain an adequate evaluation of components, two main resources will be used: reports on research and policy on vegetables by various national program teams, and an overview of vegetable research in the region based on a survey of national program personnel. The second component is a **general treatise on the vegetable research and development activities of AVRDC for the region** — what it has offered and continues to offer in the way of new vegetable technology in its service to the national programs in developing countries. AVRDC has engaged in this service since 1972. It is, therefore, appropriate, to evaluate the status of vegetable research in the region, to see whether this service has largely benefited the national programs and how it may have helped upgrade the status of vegetable research. The third component, thus, is an **evaluation report on the impact of AVRDC's vegetable research for the region**.

Crucial Issues Affecting the Region's Vegetable Industry

The workshop has also been structured to explore the vital problems of the vegetable industry in the region. While highlighting the major issues may not necessarily guarantee an outright

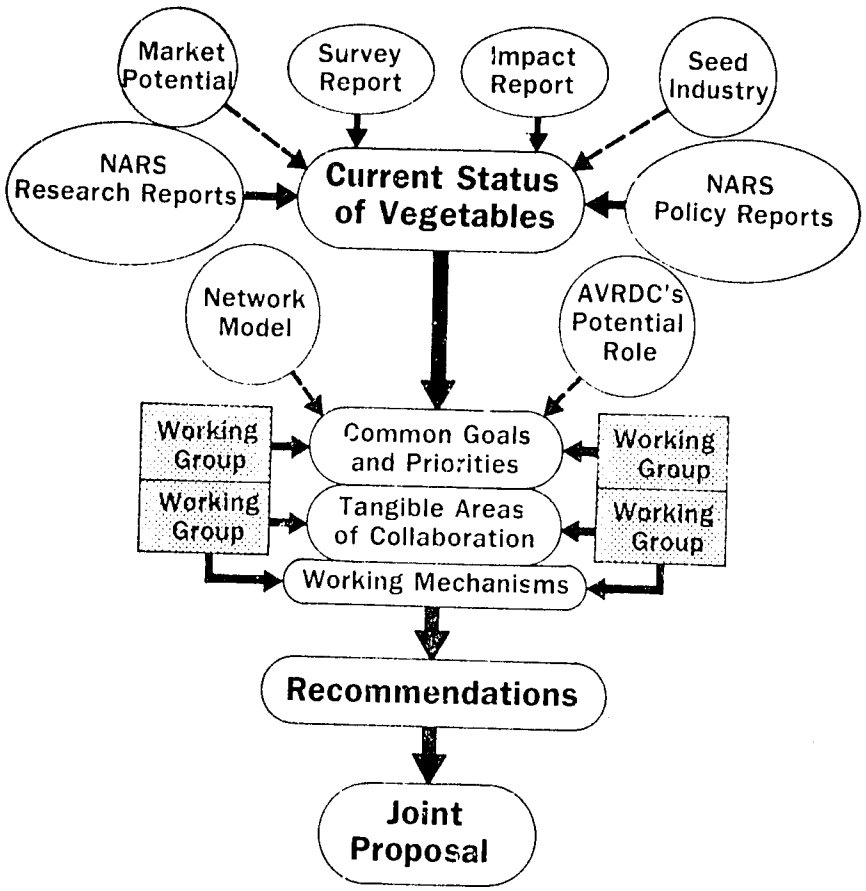

Figure 1. Stepwise mechanism of the workshop.

identification of networkable projects, the special topics on **vegetable seed industry** and the **market potential of vegetables** from the region are, in AVRDC's perception, both very important to warrant expert consultation and discussion in this workshop. The national vegetable programs gathered here will certainly attest to the special significance that is being attached to the above subjects. One only needs to recall cases of vegetable growers saving their own seeds because of the lack of good quality seeds when growers need them. And what about the woeful stories of farmers having to plow down their fields of cabbages and tomatoes because the market situation makes it is no longer profitable to harvest? We have, therefore, invited experts to tackle these issues on a regional context. Drawing expert advice from the long experience of these experts provides the participants with an objective understanding of these problems based on third-party analyses.

Successful Vegetable Industries in Asia: Model Cases for Emulation?

Although chronicling the success of the vegetable industry in neighboring countries may not be directly relevant to the issue of collaborative research, there are merits to bring them to light in this workshop, if only for national programs to draw useful lessons from. The Republic of Korea and Taiwan, China are two cases in point. In both countries the vegetable industry has been a model of strength as attested by the **flourishing and active private seed sector, extensive vegetable processing enterprise, vigorous public- and private-funded vegetable research** and traditionally **much higher per capita vegetable consumption**

compared to other countries in Southeast Asia. Are there lessons to learn from these countries? We believe there are and in this workshop we have invited two respected and experienced vegetable experts who will present an account of vegetable research and development in their respective countries.

Networking Concepts: Potential Role of IARCs and a Model of Success

Networking among agricultural researchers is not a novelty. Plucknett and Smith (1984) traced the development of the networking concept and cited examples of successful networks in relatively recent history. The international agricultural research centers (IARCs), in particular, have acted as catalysts for the development of many agricultural research networks since the 1960s. Among the oldest and most widespread of these IARC-mediated networks are the international testing nurseries (ITN). The popularity of the ITNs is understandable since they provide the crop improvement programs of the IARCs with a wide range of geographical conditions in which to evaluate genotypes. The advantages of multilocational testing are obvious. Moreover, international nurseries serve as an early warning system to monitor outbreaks of new strains of pests and diseases and to identify well in advance possible sources of resistance. One of the largest international testing networks in existence today is IRRI's International Rice Testing Program (IRTP), embracing some 1,000 rice research scientists from more than 70 rice-producing countries (see Seshu in these Proceedings). The IRTP was started in 1975 and has, hitherto, a wealth of experience on the actual working mechanisms of a network, its dos and its don'ts. We have, therefore, invited the coordinator of IRTP to provide the participants to this workshop with an inside view of how the IRTP functions and what experiences in the rice research network may be brought along to bear in any potential vegetable research collaboration in Southeast Asia.

Much like what other IARCs have done for their mandate crops, AVRDC's role in any collaborative vegetable research network in Southeast Asia would be catalytic in nature. As the major vegetable research entity for the region, AVRDC could help rationalize and encourage the formation of network(s); it may play a coordinating function for the network; it may serve as a clearinghouse for any type of network requiring a hub, e.g. informational network; it can offer training opportunities, especially short-term training programs that are functionally relevant to the network; it can provide technical help in various forms such as published materials and direct scientific consultations; and, it can, if needed, backstop with specialized research the technological needs of the national programs in the network. AVRDC can do all of these but it cannot mandate the nature and the functioning of the network. In this workshop, therefore, the AVRDC management also puts forward its views on the potential role that AVRDC could play in a scenario of regional vegetable research collaboration.

Recommendations for Collaborative Vegetable Research

Given the background information on the current status and priorities for vegetable research in Southeast Asia and other relevant information, the NARS delegates to this workshop will be taken to task to develop recommendations for collaborative vegetable research. Specifically, this will involve assessment of fiscal and human resources, physical facilities, and comparative research targets among the NARS in order to arrive in logical steps at the following requisite points before a mutually beneficial research linkage could be conceived: **assessment of common objectives and priorities; definition of tangible areas for collaborative research; development of the working mechanisms for collaboration**, including organization and network administration, network budget, and how resources and tasks are to be shared among network members; and finally, all these preparatory steps should lead to the **development of recommendations for collaborative vegetable research in the region.**

The group mechanics needed to develop the final recommendations will be the subject of a discussion session after all papers have been presented. A fundamental issue needing an

immediate answer in this session is the scope of a research network that would be appropriate for vegetables in the region. Given the current state of vegetable research, should the association be a general "umbrella" network with component subnetworks or will a series of independent and specific problem area networks be more efficient and appropriate? There would be a need to provide a rational basis for organizing the participants into working groups which will then be charged with the task to develop the final recommendations.

Joint Proposal(s) for Funding

The preparation of joint project proposal(s) is a postworkshop activity that will be greatly facilitated by the outputs generated during the workshop. It is exceedingly important that the region's NARS be very much on target with respect to their recommendations as they will be incorporated *per se* in the project proposal(s). Regardless of the scope of the network(s) that the NARS choose to organize in this workshop, the joint proposal(s) should be realistically networkable projects. These proposal(s) will be prepared at AVRDC using the outputs from this workshop. After further review by the NARS, the completed proposal(s) will then be submitted by AVRDC to the potential funding donor(s) which may also have been identified as an integral part of the recommendations.

Refining AVRDC's Research Strategies for the Region

Although this workshop is primarily aimed at exploring the potential for networking of vegetable research, an equally important spin-off is the opportunity for AVRDC, in concurrence with the region's NARS, to refine its research strategies for the region. In particular a conceptual analysis of balancing applied vs strategic vegetable research for the region may be appropriate to reflect the changing needs and capacity for research in the national programs. Since the inception of AVRDC, its strategy in generating new technology has heavily favored the problem-oriented, applied research approach. At that time the principal goal of the region's NARS was self-sufficiency in staple crops. Interest on vegetables was comparatively lower then than in recent times; therefore, the strategy to emphasize applied research was justified.

However, developments in the region in recent years, such as the infusion of improved vegetable production technology, attainment of self-sufficiency in basic staples, refocusing of national interest on "secondary" crops like vegetables, and the concomitant manpower development to implement the revised national agricultural plans herald a new phase in the relationship between a technology-producing institution like AVRDC and the NARS.

The ideal role of an international agricultural research center should be one which is supportive rather than competitive of the goals of the NARS. For diverse commodities like vegetables, which have not had the benefit of strong manpower support for many years within many NARS, this role had to be placed on a "wait and see" basis at AVRDC. As most NARS in the region appear to have enhanced their research capabilities in recent years, the role of AVRDC vis-à-vis the NARS now deserves a careful review and possible redefinition.

As the national programs assume more of the applied research activities needed to develop a strong vegetable industry, it would seem appropriate that AVRDC increase its efforts in longer range, strategic research to support the national programs.

Given sufficient time the working groups should address the issue of revising the blueprint for vegetable research for the region. Alternatively, AVRDC can develop a draft blueprint using the outputs from this workshop which could then be distributed to the region's NARS for review and amendments before AVRDC initiates its implementation. Since this blueprint constitutes a "meeting of minds" between the region's NARS and AVRDC, it is bound to help tremendously in sharply focusing projects and maximizing the expenditure of the limited resources for vegetable research in the region.

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Current Status of National Vegetable Programs

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Vegetable Production and Research Policy in the Philippines

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Vegetables in Relation to Other Crops

Vegetable crops play an important role in the economy of the Philippines as vegetable production, processing and trading provide livelihood for millions of Filipinos. The country's varied climate and geography favor the cultivation of a wide range of vegetable crops and allow specialization in the production of the more economically important vegetables.

Likewise, inherent desirable characteristics of vegetables are attributed to their diversity in species and uses. Vegetable crops have a wide range of adaptation to soil and climatic conditions, the characteristics of which proved advantageous considering the country's unique geography and varied climate.

Vegetable crops, as compared to other crop commodities, are generally early maturing, have high nutritive value and are suitable in various cropping systems, such as backyard gardening, subsistence farming, cash crop production and processed vegetable food production.

It is worth noting that income from vegetable crops is generally higher than most field crops and probably as profitable as fruit crops per unit area and time.

Domestic Production Statistics of Major Vegetables

Vegetables commonly grown in the country today consist of annual crops which include solanaceous, crucifers, cucurbits, bulb crops and other indigenous vegetables. In terms of economic value, nutrition, consumers' preference, general adaptability and extent of cultivation, the most commonly grown vegetable crops include: tomato (*Lycopersicon esculentum* Mill.) cabbage (*Brassica oleracea* var. *capitata* L.), eggplant (*Solanum melongena* L.), sweet/hot pepper (*Capsicum annuum* L. var. *annuum*), squash (*Cucurbita* sp. L.) bitter gourd (*Momordica charantia* L.), cauliflower (*Brassica oleracea* var. *botrytis* L.), broccoli (*Brassica oleracea* var. *botrytis* L.), onion (*Allium cepa* L. var. *cepa*), garlic (*Allium sativum* L.), okra (*Abelmoschus esculentus* (L.) Moench), 'pechay' (*Brassica campestris* var. *chinensis*), and kangkong (*Ipomoea aquatica* Forsskal).

The land utilization, production and mean yield for vegetable crops by region for crop year 1986 are presented in Table 1. The Ilocos Region ranked highest (24%), in terms of hectarage grown to vegetable crops, and was followed by Bicol (13%) and Central Luzon (13%).

In 1986 the Ilocos Region likewise ranked highest in crop production at 273,000 t which represents about 32% of the overall poduction of the Philippines. Central Luzon and Southern Tagalog ranked second and third, respectively, with 13% and 12% of the total vegetable produce in the country (Table 1).

There was not much change in land utilization devoted to vegetable crops from 1983 to 1986 as shown in Table 2. Likewise, only slight changes were observed in total production volume for the same period (Table 3).

Southern Tagalog, with an area of only about 16,600 ha planted to vegetables, had the highest mean yield of 6 t/ha for crop year 1986 (Table 1). Eastern Visayas, which had the lowest hectarage

utilized for vegetable crops, showed a good potential in terms of mean yield (5.4 t/ha) which was higher than most of the other regions. The mean yield for selected vegetable crops is presented in Table 4. Vegetable crops such as squash, cabbage and white potato showed consistently high yields over the four-year period.

The value of selected vegetables reached their highest figure in 1986 amounting to US$191.647 million and obtained their lowest amount in 1984 when the country experienced serious economic difficulties (Table 5).

Table 1. Summary of total vegetable hectarage, production and mean yield by region, crop year 1986.

	Region	Hectarage ('000)	Percentage (%)	Production ('000 t)	Percentage (%)	Mean yield (t/ha)
I	Ilocos	45.7	23.9	273.0	32.0	5.9
II	Cagayan Valley	12.5	6.5	39.5	4.6	3.2
III	Central Luzon	24.9	13.0	111.2	13.0	4.4
IV	Southern Tagalog	16.6	8.7	100.7	11.8	6.0
V	Bicol	25.0	13.1	67.5	7.9	2.7
VI	Western Visayas	17.8	9.3	80.2	9.4	4.5
VII	Central Visayas	9.1	4.8	31.9	3.7	3.4
VIII	Eastern Visayas	2.8	1.5	15.5	1.8	5.4
IX	Western Mindanao	4.5	2.4	14.1	1.7	3.1
X	Northern Mindanao	11.0	5.7	47.3	5.5	4.2
XI	Southern Mindanao	13.9	7.3	46.8	5.5	3.3
XII	Central Mindanao	7.2	3.8	26.6	3.1	3.6
	Total	191.0	100.0	854.3	100.0	

Source: BAS 1986.

Table 2. Land utilization for selected vegetable crops in the Philippines, crop years 1983-86.

Crop	1983	1984	1985	1986
	('000 ha)			
Major vegetables				
Cabbage	6.3	5.8	6.0	6.6
Eggplant	14.2	14.9	15.4	15.1
Garlic	8.9	5.8	6.7	6.8
Ginger	5.2	5.4	5.2	4.2
Onion (bulb)	6.7	7.8	7.0	6.5
'Pechay'	3.9	3.7	3.7	3.9
Radish	1.7	1.6	1.5	1.6
Tomato	13.6	16.0	16.4	17.4
Other vegetables				
Bitter gourd	4.3	4.4	4.6	4.6
Bottle gourd	2.7	2.7	2.5	2.5
Cucumber	1.1	1.1	1.1	1.0
Chayote	2.2	1.7	1.7	1.7
Green leafy vegetables	32.9	30.6	30.6	31.4
Green onion	2.6	2.7	2.8	2.8
Mustard	1.4	1.7	1.9	2.3
Other legume vegetables	7.2	7.3	7.6	7.3
Squash	7.1	6.5	6.7	6.7
Sweet/hot pepper	1.3	1.3	1.3	1.4
Total	123.3	121.0	122.7	123.8

Source: BAS 1983-86.

Table 3. Production of selected vegetables in the Philippines, crop years 1983-86.

Crop	1983 ('000 t)	1984 ('000 t)	1985 ('000 t)	1986 ('000 t)
Major vegetables				
Cabbage	62.86	60.71	63.71	74.11
Eggplant	109.55	104.95	96.67	88.51
Garlic	17.04	14.38	17.93	16.77
Ginger	35.86	31.00	29.39	27.50
Onion (bulb)	42.24	52.61	53.17	54.23
'Pechay'	26.54	25.80	24.54	24.87
Radish	9.10	9.28	8.47	8.92
Tomato	103.56	136.84	130.96	143.89
White potato	40.72	36.65	42.41	48.52
Other vegetables				
Bitter gourd	15.88	18.08	16.92	17.54
Bottle gourd	23.63	22.85	20.67	20.21
Chayote	16.24	12.86	12.93	12.72
Cucumber	5.80	5.90	5.58	4.31
Green leafy vegetables	79.97	78.58	78.75	80.22
Green onion	10.85	11.47	11.88	12.21
Mustard	12.69	16.46	20.65	27.23
Other fruit vegetables	27.02	24.58	32.91	35.93
Other legume vegetables	19.26	24.42	25.83	21.89
'Patola'	11.08	10.51	8.24	8.39
Squash	79.47	80.68	79.23	79.12
Sweet/hot pepper	3.02	3.02	3.24	3.61
Total	752.38	781.63	784.08	810.70

Source: BAS 1983-86

Table 4. Mean yield of selected vegetables in the Philippines, crop years 1983-86.

Crop	1983 ('000 t)	1984 ('000 t)	1985 ('000 t)	1986 ('000 t)
Major vegetables				
Cabbage	9.93	10.40	10.62	11.09
Eggplant	7.68	7.03	6.25	5.83
Garlic	1.90	2.46	2.66	2.44
Ginger	6.84	5.69	5.58	6.49
Onion (bulb)	6.89	6.73	7.60	8.34
'Pechay'	6.65	6.93	6.49	6.38
Radish	5.23	5.59	5.50	5.48
Tomato	7.60	8.52	7.98	8.23
White potato	9.69	9.45	10.82	11.82
Other vegetables				
Bitter gourd	3.67	4.08	3.67	3.77
Bottle gourd	8.63	8.40	8.27	8.02
Chayote	7.12	7.39	7.22	7.11
Cucumber	5.04	5.36	5.03	4.26
Green leafy vegetables	2.43	2.57	2.57	2.55
Green onion	4.03	4.17	4.20	4.24
Mustard	9.00	9.57	10.59	11.64
Other fruit vegetables	4.34	3.84	4.40	4.57
Other legume vegetables	2.65	3.34	3.36	3.00
'Patola'	4.72	4.65	3.51	3.37
Squash	11.15	12.28	11.79	11.72
Sweet/hot pepper	2.18	2.26	2.38	2.49
Total	127.37	130.71	130.49	132.84

Source: BAS 1983-86.

Table 5. Value of selected vegetables in the Philippines, crop years 1983-86.

Crop	1983[z]	1984[y]	1985[x]	1986[x]
	('000 t)			
Major vegetables				
Cabbage	10,225	9,096	13,634	18,354
Eggplant	22,648	15,898	24,551	23,072
Garlic	17,098	18,620	28,719	28,153
Ginger	13,905	12,343	10,600	8,388
Onion (bulb)	13,245	11,469	11,635	15,112
'Pechay'	4,230	2,848	3,701	4,028
Radish	1,853	1,368	1,639	1,839
Tomato	24,005	21,233	30,376	32,29[illegible]
White potato	8,381	6,093	9,242	13,18[illegible]
Other vegetables				
Bitter gourd	3,727	2,420	2,798	3,479
Bottle gourd	2,889	1,344	3,461	3,64[illegible]
Chayote	1,175	792	936	990
Cucumber	1,128	624	889	671
Green leafy vegetables	9,534	5,954	8,792	9,330
Green onion	3,918	3,184	3,987	4,072
Mustard	1,800	1,732	2,771	3,699
Other fruit vegetables	3,808	2,348	5,374	5,970
Other legume vegetables	5,619	4,114	6,479	4,800
'Patola'	1,895	929	976	1,093
Squash	9,228	6,239	8,226	8,063
Sweet hot pepper	2,081	793	1,156	1,414
Total	162,392	129,441	179,942	191,647

Source: BAS 1983-86 [z]US$1.00 = P11.00 [y]US$1.00 = P21.00 [x]US$1.00 = P21.00

Vegetables as Export Crops and Foreign Exchange Earners

The country has a small export of selected vegetable crops, either in fresh or processed/dried form. Export markets include: Hong Kong, Japan, the USA, Canada, the Netherlands, the United Kingdom, Ireland, Guam and others. In 1985 the country exported a total of 9,439 t valued at FOB US$3.79 million (Table 6). On the other hand, the country's imports during the same period, which consisted mainly of tomato puree, dried green peas, and other preserved tomato amounted to CIF US$5 million (Table 7). In the same year, the country also imported its seed requirements valued at CIF US$759 thousand. In 1986 vegetable seeds were imported amounting to CIF US$944 thousand (Table 8). During this year seed importation exceeded exportation, which implies that there is room to expand vegetable production in the country.

Improving Rural Farm Income

Vegetable production holds potential as an economic springboard for rural families from the nutrition standpoint and augmentation of the farm family income.

Besides its diversity and compatibility in most cropping systems, it requires little investment, especially for a typical subsistence farmer. In the Philippines subsistence farming and home gardening are the most common cultural practices for vegetable production. Various kinds of vegetables from green leafy to the succulent types which are readily adapted to local conditions are usually grown utilizing labor from farm household members. Thus, it is generally an inexpensive way of providing a continuous supply of fresh vegetables for the farm family, which can be easily improved to augment the family income.

Table 6. Vegetable exportation in the Philippines, 1985.

Commodity	Volume (t)	Value (US$) FOB[z]	CIF[y]
Beans, mungo (green/yellow) dried (NK)[x]	5	7,318	8,515
Beans, red, dried (NK)	36	23,220	24,906
Other peas, dried (NK)	16	10,736	11,833
Onions, fresh or chilled	7,756	2,109,228	2,709,897
Pepper, sweet, fresh or chilled (GK)[w]	10	3,954	9,124
Other fresh or chilled vegetables (artichokes, gourds, parsley, etc.) (GK)	727	771,841	1,553,939
Other vegetables, preserved by freezing (GK)	100	97,180	113,672
Cucumbers and gherkins in brine or other temporary preservation (GK)	161	50,357	60,535
Other vegetables in brine or other temporary preservations (GK)	132	43,193	56,500
Other vegetables products, chiefly for human food, fresh or dried, N.E.S.[v] (NK)	15	10,326	11,000
Other dehydrated or evaporated vegetables (including powdered) (GK)	32	4[illegible],004	51,284
Other vegetables, prepared or preserved in vinegar (NK)	104	119,602	134,442
Other beans, N.E.S. prepared or preserved other than vinegar or acetic acid	109	166,527	186,380
Mustard, prepared or preserved other than vinegar or acetic acid N.E.S. (NK)	23	53,191	58,304
Peas, chick ('garbanzos') prepared other than in vinegar or acetic acid (NK)	23	53,191	58,304
Vegetables preserved in tomato sauce or in water (NK)	202	262,035	304,055
Others	11	22,629	25,763
Total	9,462	3,851,532	5,378,453

Source: NCSO 1985. [z]FOB: Freight on board. [y]CIF: Cost in freight. [x] NK: Net kg. [w]GK: Gross kg. [v]N.E.S.: Not elsewhere specified.

Government action programs on selected vegetables have shown promise of being profitable. Initial results of its pilot action program on mungbean production, which is funded and coordinated by the Philippine Council for Agriculture, Forestry, Resources Research and Development (PCARRD), showed its viability as a good cash crop. Farmer-cooperators in Ilocos Norte, one of the selected sites, derived positive returns of investment (ROI) averaging 310%. In Ilagan, Isabela, where improved mungbean varieties were also pilot tested, an average ROI of 344% was attributed from Taiwan Green, an introduced AVRDC mungbean variety using the recommended component production technology. The profit was about US$532.45/ha compared to the traditional varieties like MG50-104 and CESID-21 which gave only about US$279.50/ha.

Also potentially promising in terms of profit is tomato. Processing tomatoes which are usually contracted out to farmers have gained net profits averaging US$833/ha per cropping season.

There is clearly a need for government support, such as the above-mentioned pilot action programs, so that farmers are offered a wider range of production options from which to choose, to improve their farm level economy.

Vegetables and Human Nutrition

The importance of vegetables in the Filipino diet has been long recognized. As a program, nutrition has always been part of the government's efforts in national development. Nowhere,

Table 7. Vegetable importation in the Philippines, 1985.[z]

Commodity	Volume (t)	Value (US$) FOB[z]	CIF[y]
Beans, white dried (NK)[x]	206	135,635	149,837
Beans, mungo (green/yellow) dried (NK)	1,049	153,156	184,754
Beans, red, dried (NK)	303	91,736	99,585
Peas, chick ('garbanzos') (GK)	246	158,608	172,390
Peas, green ('chicharo') dried (NK)	2,427	669,592	782,691
Tomatoes, fresh or chilled (GK)	6	5,062	10,649
Broccoli, fresh or chilled (GK)	7,212	9,872	14,755
Peas, green, fresh or chilled (GK)[w]	51	9,694	12,449
Banana blossoms, dried (NK)	26	9,420	10,266
Mushrooms, dried (NK)	1	8,713	9,181
Asparagus, dehydrated or evaporated, powdered (GK)	0.12	10,680	10,816
Garlic, dehydrated or evaporated, powdered (GK)	26	46,057	48,761
Onions, dehydrated or evaporated powdered (GK)	20	45,232	50,009
Cucumber, gherkins and similar vegetables pickled (NK)	27	12,538	14,690
Olives and capers, pickled (NK)	6	10,412	11,097
Other vegetables, prepared or preserved in vinegar	33	52,292	60,644
Asparagus, prepared or preserved in vinegar	81	102,883	111,571
Mushrooms, prepared or preserved in vinegar (NK)	65	74,571	77,887
Tomato puree (paste) and concentrate (NK)	3,556	2,290,228	2,435,124
Tomatoes, prepared other than in vinegar (NK)	651	423,330	447,268
Other vegetables prepared preserved other than vinegar (NK)	129	64,962	72,772
Others	368	110,861	141,682
Total	16,490	4,495,534	4,928,878

Source: NCSO 1985. [z]FOB: Freight on board. [y]CIF: Cost in freight. [x]NK: Net kg. [w]GK: Gross kg.

is this best exemplified than in its education curricula. Virtually all school programs at all educational levels extol and promote nutrition as a crucial adjunct to national development. More recently the government has intensified promotional programs and information campaigns through the media, rural health workers and agricultural extension personnel. Vegetables constitute a major content of these efforts to promote nutrition, since most of the local vegetable crops are rich sources of vitamins A, C, thiamine, niacin and other essential elements needed for the human health. Despite these efforts, however, local production still falls short of meeting the domestic requirements. Consequently, this has affected the consumption rates. Thus, even if one assumes that all vegetables produced at present levels are consumed, the daily per capita consumption in many parts of the country remains low.

Findings by the Food and Nutrition Research Institute (FNRI 1986) revealed that the average vegetable consumption by Filipinos is only 106 g/day, which is still substantially below the daily minimum requirement of 300 g of vegetables per person per day. On a regional basis, the average daily vegetable consumption in Southern Tagalog and Western Visayas is about 40 g; Central Luzon, 61 g; Mindanao, 74 g; Eastern Visayas, 85 g; Ilocos, 115 g; Bicol, 133 g; and Cagayan Valley, 295 g.

Table 8. Vegetable seed importation in the Philippines, 1985-86.

Crop	1985		1986	
	Quantity (t)	Value (US$)	Quantity (t)	Value (US$)
Asparagus	.03	426	n.a.[z]	n.a.
Beans	.56	2,373	.86	2,600
Beets	.07	389	.15	744
Broccoli	.01	1,323	.02	1,458
Cabbage: Hybrid	.62	23,499	1.40	103,788
Open pollinated	1.80	14,326	.46	3,906
Cauliflower	.14	4,339	.22	3,829
Cantaloupe	.65	6,788	3.00	17,572
Celery	.04	1,765	.10	155
Chinese cabbage: Hybrid	.15	8,904	.46	15,836
Open pollinated	.43	4,976	–	–
Cucumber	.84	11,891	.66	7,147
Mustard	3.00	5,127	2.00	2,455
'Pechay'	23.00	33,750	5.00	6,650
Peas	.52	520	.20	312
Onion: Hybrid	3.00	121,812	4.30	201,592
Open pollinated	18.00	255,151	20.00	318,499
Radish	24.00	37,335	15.00	23,246
Watermelon	13.00	122,769	15.00	136,054
Squash	.19	1,968	.002	19
Tomato	.06	1,755	.12	4,253
'Kulantro'	.30	250	.40	400
Eggplant	.10	4,885	.14	4,980
Lettuce	.16	2,714	.53	7,035
Carrots	8.30	74,450	13.00	79,444
Parsley	.01	159	.005	47
Spinach	.39	4,820	n.a.	n.a.
Okra	.24	757	.26	762
Sweet Corn	.10	600	.24	66
Chinese cabbage	–	–	.30	540
Bunching onion	–	–	.02	210
Total	99.71	749,821	83.847	943,599

Source: BPI 1987. Seeds were imported mostly from the USA, Japan, Denmark and Taiwan. [z]n.a. = not applicable.

The reasons cited for these varying intakes among regions include such factors as shifting preference, population growth and market pressure, in which the bulk of the produce in some regions is marketed in areas where there is high demand for a particular vegetable crop.

The Philippines government now seeks to fully address the issue of low vegetable consumption intakes which can relate to low nutritional status, especially among Filipino children, through programs which can give vegetable production, particularly the areas of subsistence farming, their needed boosts through programs of immediate consumer impact and for the long term through adequate support to research efforts.

Research, Finances and Manpower Development

National Research Policy

Realizing that the development of the vegetable industry is essential to the attainment of national goals, the Philippines is attempting to make the industry economically viable. With

the present government's thrust towards self-sufficiency in food and enhancement of proper nutrition, it is imperative to strengthen the vegetable (including legumes and root crops) research and development program to help bring about these objectives of the government.

PCARRD, which is committed to the effective and efficient management of agriculture and resources research, has given the vegetable commodity one of the top priorities in the national research and development (R and D) program through increased budgetary support and greater consideration of R and D project proposals submitted by various research institutions on the commodity.

Moreover, the recent reorganization of the government under the present leadership, likewise strengthened PCARRD's mandate as elucidated under Section 13 of Executive Order 128 signed on 30 January 1988. PCARRD shall be responsible for the following:

a. Formulation of strategies, policies, plans, programs and projects for science and technology development;
b. Programming and allocation of government and external funds for R and D activities;
c. Monitoring of R and D projects; and
d. Generation of external funds.

Among its major tasks, PCARRD has been mandated to estabish, support and manage the operation of a national network of research centers and stations in agriculture and natural resources. To do this PCARRD has established the National Agriculture, Resources Research and Development System (NARRDS), which is a strategy as well as a mechanism to allow maximum participation of all components of the R and D network. Closer working relationships among scientists working on common R and D activities are fostered through this mechanism. The NARRDS includes various agencies independent of PCARRD, but their R and D activities are coordinated by PCARRD. Member agencies have been organized into national and regional centers and cooperating stations with well-defined functions in terms of commodity and disciplinary specializations. They were selected on the basis of their regular R and D budget; technical and manpower capabilities, land and water resources and physical facilities, and the potential to service a farming area.

The network of research centers and stations in the Philippines with their corresponding responsibilities is presented in Table 9 and Fig. 1.

Table 9. Network of research centers and stations for vegetable crops.

Center	Responsibility
National Research Center	
University of the Philippines at Los Baños (UPLB), College, Laguna	Responsible for both basic and applied research. Research in basic disciplines like systematics, physiology, biochemistry, genetics, etc. are conducted at the national center. Applied research in pathology, ecology, etc, which require strong support from the basic disciplines, are likewise conducted at the national center to put together technology packages appropriate for the different crops and/or dominant farming or production systems, after successful trials in the regional center and cooperating stations located throughout the country.
Regional Research Centers	
Benguet State University (BSU), La Trinidad, Benguet	Conducts applied research for crops of major importance in the region where it is based. Conducts studies to localize the findings from the national center. Fine-tunes technology packages

Table 9. Continued.

Center	Responsibility
	conceptualized in the national center for application or adaption to the needs and conditions of the region.
Isabela State University (ISU), Isabela	- do -
Central Luzon State University (CLSU), Muñoz, Nueva Ecija	- do -
Mariano Marcos State University (MMSU), Batac, Ilocos Norte	- do -
Department of Agriculture Davao Experiment Station (DA-Davao), Bago-Oshiro, Davao City	- do -
Department of Agriculture La Granja Experiment Station (Da-La Granja) La Granja, La Carlota City	- do -
Palawan National Agricultural College (PNAC), Aborlan, Palawan	- do -
University of Southern Mindanao (USM), Kabacan, South Cotabato	- do -
Visayas State College of Agriculture (ViSCA), Baybay, Leyte	- do -
Cooperating Stations	
Abra State Institute of Science and Technology (AS'ST), Abra	Undertakes adaptive trials or field experiments where microdifferences in the environment are taken into account. Only the most promising and locally relevant treatments are included.
Department of Agriculture (DA) Bureau of Plant Industry, Baguio Experiment Station (BPI-BES), Baguio City	- do -
Department of Agriculture (DA) Bureau of Plant Industry, Bicol Experiment Station (BPI-BEST), Pili, Camarines Sur	- do -
Department of Agriculture (DA) Bureau of Plant Industry, Economic Garden (BPI-EG) Los Baños, Laguna	- do -
Department of Agriculture (DA) Bureau of Plant Industry, Ipil Experiment Station (BPI-Ipil), Zamboanga del Sur	- do -
Department of Agriculture (DA) Bureau of Plant Industry, Mandaue Experiment Station (BPI-MES), Mandaue City	Undertake adaptive trials or field experiments where microdifferences in the environment are taken into account. Only the most promising and locally relevant treatments are included.
Department of Agriculture (DA) Misamis Oriental Horticultural, Research Center (BPI-MOHRC), Dalwangan, Malaybalay, Bukidnon	- do -
Twin Rivers Research Center (TRRC), Tagum, Davao del Norte	- do -

Financial Allocations

In general, coconut (18.22%) received the largest budgetary support over the four-year period followed by root crops (16.55%) and legumes (10.69%). The budgetary allotment for vegetable research is only 7.37% of the total allocation. This figure represents funds provided by the Philippine government and financial support from international donors.

Manpower Development

In terms of manpower development program, the NARRDS (through PCARRD) have strengthened their linkages with international research and training centers, notably, the Asian Vegetable Research and Development Center (AVRDC), the Centro International de Agricultura Tropical (CIAT) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

It is worthwhile to note that AVRDC has contributed in no small measure to the improvement of manpower capabilities to address the important requirements of the vegetable commodity in the Philippines. The country has sent some 124 Filipino trainees to various training programs at AVRDC related to varietal improvement; horticultural crop production and management and other relevant aspects of vegetables specific to Asian countries. Figure 2 shows the trend in number of Filipino researchers/participants who joined the program from 1974 to 1988.

Constraints in Vegetable Production

The vegetable industry in the Philippines still faces many problems in aspects such as production, marketing, improved technology, and aspects attributed to the human elements of the industry. These constraints are discussed below.

Seasonality

The vegetable supply during the dry season exceeds the effective demand and results in low vegetable prices; thus, rendering vegetable production unattractive. On the other hand, since the areas that would be planted to vegetables are reduced during the rainy season, there is a big demand for high-quality vegetables in the market during the wet season.

The high frequency of typhoons and the heavy rainfall during the monsoon months not only limit production but also contribute to the poor quality of the crop produced. A high incidence of pests and diseases is usually observed during this season.

Unavailability of High-Quality Seeds

The unavailability of seeds of some improved varieties constitutes one of the major limitations of the vegetable industry in the country. Seeds of high-yielding foreign varieties that are found adaptable to local conditions are imported. This unduly results in a drain on the country's meager foreign reserves.

Maintenance of seed quality is another related problem. The practice of using seeds from previous crops has considerably increased the outbreak of diseases. More efforts should be exerted to develop high-yielding varieties with multiple resistance to major pests and diseases. Varieties adapted to various cropping systems under a wider range of environmental conditions should meet both fresh market and processing standards.

Efforts should likewise be exerted to develop indigenous vegetables like kangkong, 'malunggay' (*Moringa oleifera* Lam.), 'alugbati' (*Basella rubra* L.) and others. Apart from their popularity and preference in the urban and rural areas, they are more nutritious than the commercial vegetables.

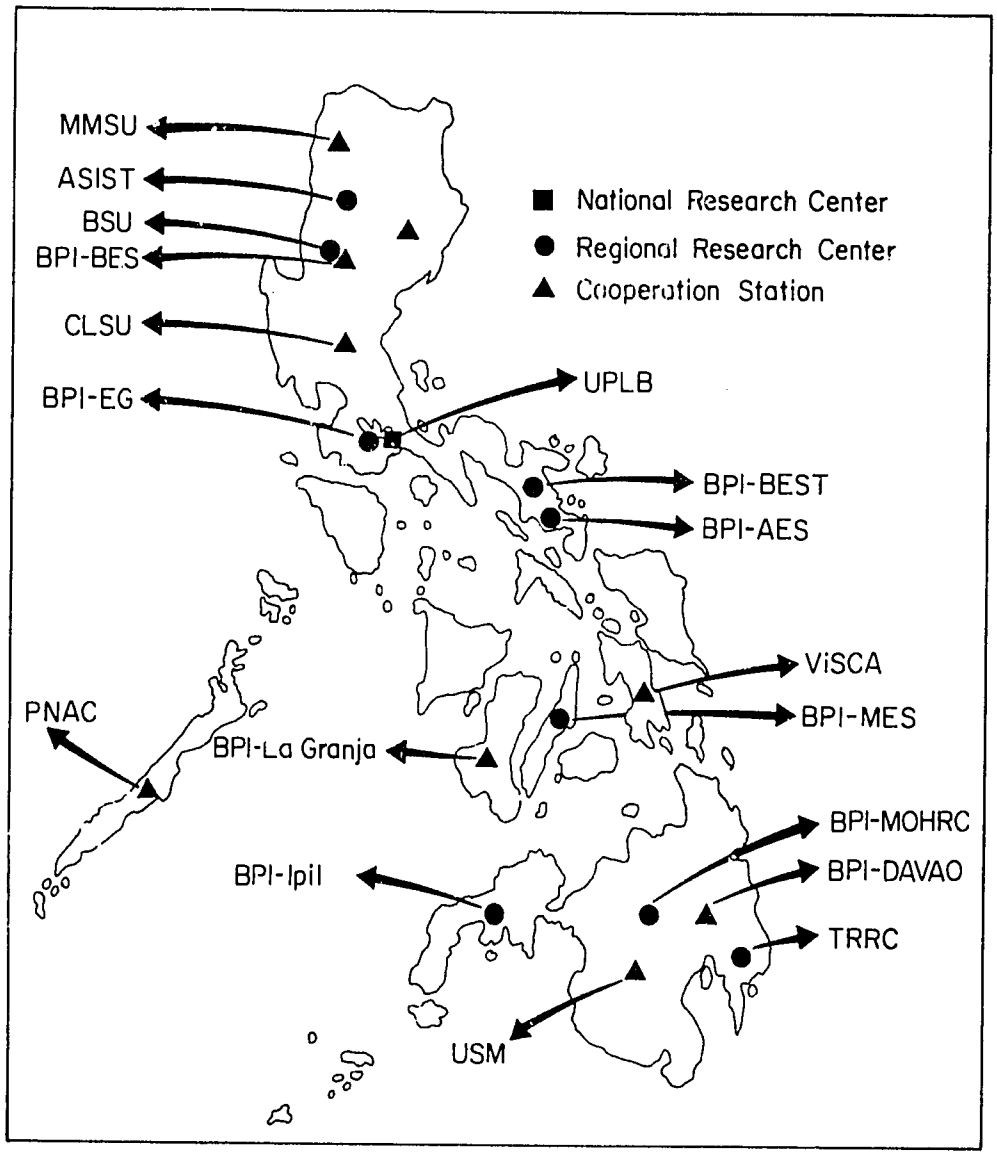

Figure 1. National vegetable crops network, Philippines.

Cultural Management

The poor implementation of insect and disease control measures, coupled with the use of poor varieties, are some of the more serious problems in vegetable production. These problems are compounded by difficulties in land preparation, poor drainage systems and ineffective control of weeds during the wet season. During the dry season, the more important problems include proper and timely application of irrigation water, fertilizer and chemicals as well as the maximum utilization of land through a systematic cropping system.

Marketing

The most common problem encountered is the proliferation of marketing channels. The commodity reaches the consumer after a longer time and without any improvement in the quality

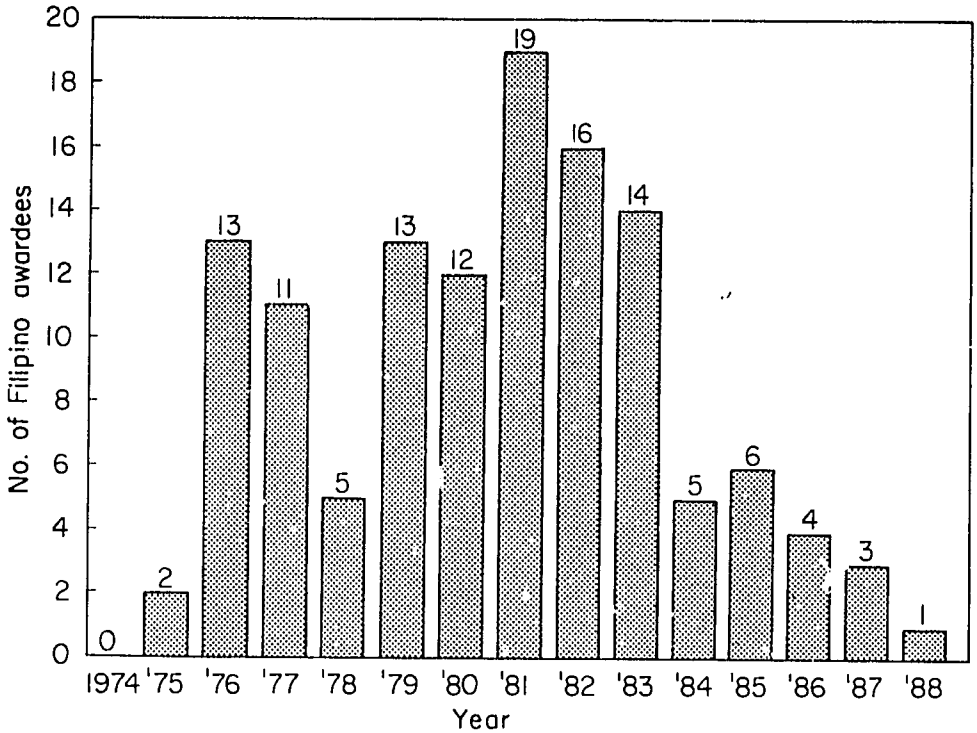

Figure 2. Number of Filipino awardees in various AVRDC training programs, 1974-88.

of the product, thus increasing the marketing costs. This is further aggravated by the perishability of the vegetables themselves.

The lack of market information poses another constraint for the farmers and producers who are unable to derive a fair price for their produce due to lack of awareness of prices.

Postharvest Handling and Utilization

Together with high perishability of vegetables, the absence of grading standards, improper handling and packaging and the lack of storage and transportation facilities likewise pose great problems in production areas. More effort should be made to develop technologies that can reduce storage losses, improve vegetable shelf life, processing and postharvest facilities.

Inadequacy of Credit Facilities

Banks are generally reluctant to extend loans to vegetable farmers due to the high risk involved in vegetable production. Some lending programs, both government and private institutions, are usually directed to or biased towards providing financial assistance only for specific crops. As a result farmers are forced to turn to usurious lenders for credit.

Technology Transfer

There is also the human dimension which concerns the farmer's hesitancy to adopt new technologies. This calls for a need to look into the extension aspect and how effective these strategies are or have been.

Today, the national research and development program for vegetable crops is basically aimed at two major thrusts, namely: (a) increase in production in order to attain self-sufficiency, stabilize

domestic supply of vegetables throughout the year, optimize farm productivity and provide the people with inexpensive sources of nutritious food; and (b) improvement in the quality of vegetable crops for export.

The vegetable R and D program, therefore, emphasizes specific priority R and D areas to answer the pressing problems of the industry. These areas include varietal improvement, crop culture and management, crop protection, economics and marketing, seed production, postharvest handling and utilization and extension.

Resource generation for R and D has been a necessary exercise for PCARRD because government funds for these activities have always been limited. For the past years, the rate of Philippine expenditures for R and D in agriculture and natural resources was less than 0.2% of the gross volume added (GVA) and declining in real terms. The ratio for other Asian countries is between 0.4% and 0.6%, while among developed nations the ratio exceeds 1.5%. The financial allocation to support research on vegetable crops compared to 11 other crop commodities from 1985 to 1988 is presented in Table 10.

Table 10. Financial research allocation for 12 crop commodities in the Philippines, 1985-88.

Crop	1985			1986			1987			1988			Total		
	No. of studies	Budget[1] (US$ '000)	%	No. of studies	Budget[1] (US$ '000)	%	No. of studies	Budget[1] (US$ '000)	%	No. of studies	Budget[1] (US$ '000)	%	No. of studies	Budget[1] (US$ '000)	%
Coconut	103	670	20.22	136	406	15.29	174	801	21.68	84	682	15.58	497	2,559	18.23
Corn	178	264	7.96	97	177	6.66	156	162	4.37	129	197	4.50	560	800	5.69
Fiber crops	113	187	5.64	182	230	8.65	165	200	5.41	169	395	9.02	629	1,012	7.21
Fruit crops	98	225	6.79	110	196	7.38	168	318	8.61	192	390	8.91	568	1,129	8.04
Legumes	244	365	11.10	140	407	15.32	154	218	5.90	231	512	11.70	769	1,502	10.70
Ornamentals and medicinal crops	70	90	2.72	67	74	2.79	68	46	1.28	96	124	2.83	301	334	2.38
Plantation crops	62	89	2.69	57	82	3.09	83	120	3.25	100	161	3.68	302	452	3.22
Rice	309	224	6.76	253	134	5.05	368	401	10.86	308	500	11.42	1,238	1,259	8.97
Root crops	240	488	14.66	290	548	20.63	366	668	18.08	370	634	14.48	1,266	2,338	16.65
Sugarcane	94	209	6.31	51	10	0.38	126	138	3.74	111	153	3.49	382	510	3.63
Tobacco	162	264	7.97	171	143	5.38	149	361	9.78	98	342	7.81	580	1,110	7.90
Vegetables	173	238	7.18	162	249	9.38	187	260	7.04	180	288	6.58	702	1,035	7.38
Total	1,846	3,313	100.00	1,716	2,656	100.00	2,165	3,693	100.00	2,068	4,378	100.00	7,794	14,040	100.00

Source: PCARRD 1985-88. [1]US$1.00 = ₱20.00.

Future Directions

The development of the Philippine vegetable industry remains one of PCARRD's focus of concern and will be in the years ahead. This concern is spelled out in the National Research and Development Thrusts it has drawn up to serve as its five-year medium-term operational plan from 1988 to 1992. The plan was evolved through consultation with concerned research and other related institutions, such as the Department of Agriculture (DA), the State Colleges and Universities (SCU), and the private sector.

On the basis of the National Development Plan formulated by the National Economic and Development Authority (NEDA), the following broad R and D thrusts for the various commodities, including vegetable crops were identified:

a. Profitable production and postproduction technologies;
b. Development, rehabilitation, conservation, utilization and management of resources and ecosystems;
c. Production, processing, storage and distribution systems for seeds, stocks and planting materials;

d. Breeding for better production;
e. Biotechnology in production and postproduction systems;
f. Integrated and commodity-based approaches towards better food production, nutrition and balanced ecosystems;
g. Effective and efficient technology transfer systems for producers and enterprises; and
h. Efficient marketing, distribution and support systems.

For vegetables, these directions cover and comprehensively address the key problems discussed under constraints in vegetable production. They essentially respond to the long-range goal of the industry, which is eventually to produce and make available vegetable commodities the whole-year round at a cost and quality acceptable to the consumers. The supply of high-quality seeds is essential to achieve this critical thrust. Future plans of the government for the commodity are geared towards the effective production and distribution of high-quality seeds. Self-reliance and the sustained availability of good quality seeds is the key to the industry's success. This area covers the critical aspect of seed production, such as appropriate cultural management, seed quality determination/maintenance, seed processing systems and facilities, seed storage structures along with marketing and extension strategies. Another area which should be developed is institutional support for these areas of concern. Fortunately, this is now being attended to and can be expected to receive increased attention under PCARRD's plan for the next few years.

In terms of investment in research, it is to be noted that the trend for research allocation for the commodity has risen in the last three years (Table 10). However, procuring adequate funds still remains a critical factor since there are other commodities, i.e. farming systems, livestock, socioeconomics, that share in the total research budget aside from the 12 crop commodities presented. Recognizing this, the government continues to explore the generation of funds from sources other than the regular government allocation to supplement additional requirements to further strengthen the commodity. Several linkages have been forged in this respect which include the International Development Research Centre (IDRC) of Canada, AVRDC, CIAT, the World Bank through the Agricultural Support Services Project (ASSP) and the United States Agency for International Development (AID) through the Rainfed Resources Development Project (RRDP).

Also in consonance with government policy to extend maximum support to the industry is the continuous upgrading of research manpower capabilities to sustain development efforts through local and international training programs and participation at related vegetable workshops and conferences.

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5

Research on Vegetables in the Philippines

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Important Vegetables in the Country

Based on available data on the value of production, the leading vegetables in the Philippines are shown in Table 1. Crops that are considered important, but are not specifically cited in vegetable statistics, are: *Vigna unguiculata (L.) Walp. subsp. sesquipedalis* (L.) Verdc., *Pisum sativum* L., *Psophocarpus tetragonolobus* (L.) DC., *Abelmoschus esculentus* (L.) Moench, *Citrullus lanatus* (Thunb.) Matsum. and Nakai var. *lanatus* and *Cucumis melo* L. These first three vegetables are probably included under the heading "Other legumes" while *A. esculentus* is probably listed under "Other fruit vegetables". "Other leafy vegetables", the group that accounts for the biggest hectarage, must include *Ipomoea aquatica* Forsk., *I. batatas* (L.) Lam. and *Colocasia esculenta* (L.) Schott grown for their leaves. *Moringa oleifera* Lam. and *Basella alba* L. must also be included in this category.

Table 1. Vegetable production statistics in the Philippines, 1983-84.

Vegetable	Harvested area ('000 ha)	Yield (t/ha)	Production ('000 t)	Wholesale value (million US$)
Major vegetables	132.80	5.67	753.52	–
Lycopersicon esculentum Mill.	16.06	8.52	136.84	37.73
Solanum melongena L.	14.91	7.04	104.95	16.64
Allium cepa L. var. *cepa* and *A. ascalonicum* L.	7.82	6.73	52.61	33.90
Allium sativum L.	5.88	2.45	14.38	35.80
Brassica oleracea var. *capitata* L.	5.84	10.40	60.71	20.47
Zingiber officinale Roscoe	5.44	5.70	31.00	22.81
Brassica campestris subsp. *chinensis* L.	3.72	6.94	25.80	8.70
Raphanus sativus L.	1.66	5.59	9.28	1.79
Minor vegetables	71.48	4.45	317.95	–
Other leafy vegetables	30.61	2.57	78.58	–
Other legumes	7.32	3.34	24.42	–
Other fruit vegetables	6.40	3.84	24.58	–
Cucurbita moschata (Duch.) Duch. ex Poiret	6.57	12.28	80.68	12.50
Laqenaria siceraria (Molina) Standl.	2.72	8.40	22.85	2.56
Momordica charantia L.	4.43	4.08	18.08	4.75
Allium fistulosum L.	2.75	4.17	11.47	–
Phaseolus vulgaris L.	2.52	3.39	8.54	2.74
Luffa aegyptiaca (Mill) and *L. acutangula* (L.) Roxb.	2.26	2.61	5.90	1.03
Sechium edule (Jacq.) Swartz	1.74	7.39	12.86	1.79
Brassica juncea (L.) Czernj. and Coss.	1.72	9.57	16.46	--
Cucumis sativus L.	1.10	5.36	5.90	–
Capsicum annuum L. var. *annuum*	1.34	2.25	3.02	–

Source: BAEcon 1985.

Citrullus lanatus and *Cucumis melo*, classified as vegetables by textbook definition, are listed under fruit crops in official statistics of the Philippines. In 1983-84 a total area of 5,370 ha was planted to these crops which yielded total harvests worth US$14.4 million.

Three crops of the Asian Vegetable Research and Development Center (AVRDC), namely: *Ipomoea batatas* when grown for its roots, *Vigna radiata* L. Wilczek and *Glycine max* (L.) Merr., are not considered as vegetables. *Ipomoea batatas* is correctly listed as a root crop, while *Vigna radiata* and *Glycine max* are classified as grain or field legumes. The area planted to *I. batatas* in 1983-84 (168,180 ha) exceeded the total area planted to all other vegetables (132,800 ha). *Vigna radiata* was planted to 35,400 ha, while *Glycine max* was planted to 7,600 ha.

Among the crops listed above, *G. max* stands out as essentially an imported commodity. The Philippines imported 65% of its raw soybean and 92% of its soybean meal in 1982-83. Tomato paste worth US$4.2 million was also imported in 1987. The supply required to meet local demand of all other crops are produced domestically, except for some processed products and garlic which are imported during years of low production.

Current National Research Program

Vegetables ranked sixth among the 12 commodity groups which received fund allocations for crop research in 1988, with an allotment of 7.05% of the national crop research budget (Table 2). In 1988 the national research system allocated a total of US$0.25 million for vegetable research. This amount was distributed to six research disciplines, with crop improvement receiving the largest share of US$0.12 million (50.7%), and crop protection ranking second with US$0.06 million (23.9%) (Table 3).

Table 2. Fund allocation for research and development in agricultural crops in the Philippines, 1987.

Crop	Annual budget (million US$)	Percentage	Rank
Coconut	0.77	21.70	1
Corn and sorghum	0.16	4.40	9
Fiber crops	0.19	5.40	8
Fruit crops	0.31	8.63	5
Legumes	0.21	5.91	7
Ornamental and medicinal plants	0.04	1.26	12
Plantation crops	0.12	3.26	11
Rice, wheat and other cereal grains	0.38	10.83	3
Root crops	0.64	18.10	2
Sugarcane	0.13	3.75	10
Tobacco	0.34	9.77	4
Vegetables	0.25	7.05	6
Total	3.54	–	–

Source: PCARRD data base.

Table 3. Summary of ongoing vegetable research by discipline, PY 1988 Phase B.

Discipline	Budget (US$)	Percentage (%)
Crop improvement	124,643	50.6
Crop production and management	34,937	14.2
Crop protection	58,877	23.9
Crop processing and utilization	10,002	4.1
Seed production technology	11,696	4.8
Crop physiology	5,895	2.4
Total	246,050	

Source: PCARRD data base.

The major public institutions (in order of decreasing involvement) working on vegetable research are:

1. University of the Philippines at Los Baños (UPLB)
   - Institute of Plant Breeding (IPB)
   - National Crop Protection Center (NCPC)
   - Postharvest Training and Research Center (PHTRC)

2. Department of Agriculture (DA)
   - Bureau of Plant Industry, Economic Garden (BPI-EG)
   - Misamis Oriental Horticultural Research Center (MOHRC)

3. State Colleges and Universities
   - Benguet State University (BSU)
   - Mariano Marcos State University (MMSU)
   - Central Luzon State University (CLSU)
   - Visayas State College of Agriculture (ViSCA)

In terms of diversity of projects, resources and manpower committed to vegetable research, IPB and BPI-EG, which are both based in Los Baños, are the leading public research organizations working on vegetables. IPB covers the breeding/variety testing of 30 crops belonging to eight families. BPI-EG is the Philippine arm of AVRDC and, thus, focuses on AVRDC crops.

Since the 1950s the fresh market tomato, among all vegetables, has been the main crop in public sector research. It continues to be the leading crop in terms of research resource allocation.

Other vegetables with a relatively long history of substantial public sector research (more than 20 years) are: *Vigna unguiculata* subsp. *sesquipedalis*, *Solanum melongena*, *Capsicum annuum* var. *annuum*, *Cucumis sativus*, *Brassica oleracea* var. *capitata*, and *Allium cepa* var. *cepa*. However, research on most vegetables has been sporadic. Today, the public sector research is generally comprehensive since it covers many important crops and disciplines; but it may be lacking in depth in many subjects, and is certainly inadequately supported. For example, many of the projects listed under crop improvement are concentrated only in variety testing, while those under crop protection are involved only in pesticide testing.

Private sector research has diversified in the last 10 years. It is currently most active in varietal development of all important and minor vegetables, except *Allium sativum* and *Zingiber officinale*, seed production and pest control (pesticide testing).

Unlike pesticide testing, which has been the mainstay of private sector research, varietal development by the private sector is fairly recent. The pioneer in this area is Eden Farms in Mindanao, which started research and development (R and D) in the late 1970s. This was followed in quick succession by East-West Seed Co. and Kaneko Seed Co. in the early 1980s.

Constraints to Vegetable Research

Biotic Constraints

Lack of germplasm. Varietal development, which is the leading research discipline (in terms of fund allocation), is hampered by lack of germplasm. This is primarily because of the following factors: (a) inadequate local exploration and collection; (b) the limited germplasm collection in the National Plant Genetic Resources Laboratory (NPGRL) still awaits documentation and evaluation; and (c) international sources are inadequate, particularly among the minor vegetables.

Pests. Weeds, diseases and insects always cause problems in the field and sometimes even in greenhouse experiments. Pest control uses up a fairly large share of the operating funds. In

many cases pests are very difficult to control, e.g. weeds during the wet season, thrips, diamondback moth, bacterial wilt and viruses. At best, these pests complicate the interpretation of experimental results and at worst they render the experiments useless.

Abiotic Constraints

Lack of qualified personnel. The country does not have a single Ph.D. scientist who is working full-time on vegetable research. The few full-time master and bachelor degree holders working on vegetables are thinly spread to different crops, disciplines and regions of the country.

Lack of funds. The country's total funds for vegetable research (US$0.25 million) is not even enough to pay one executive in the United States of America; it is lower than the amount allocated by the Philippine Tobacco Administration (PTA) to tobacco research. A large fraction of these funds are short term in nature (one to three years). This partly explains the preponderance of 'quickie' research, such as variety testing.

Management. Since most of the research activities are in the public sector, they are hampered by government procedures. Some of these are: low pay for researchers (second-class status in some universities), red tape, ban on purchase of equipment and other forms of foreign exchange control.

Funding and Manpower Needs

Additional investments in vegetable research can be directed to the following areas.

High-level Manpower Development

This is required particularly in plant breeding, seed technology, virology and entomology where the manpower shortage is most acute. Unless this is achieved, research in the Philippines will continue to be predominantly adaptive (dependent on AVRDC' and developed-country research) instead of creative or knowledge-generating, even if funds are drastically increased.

Sustained Funding for Research Operations

Sustained funding is required, particularly for long-term projects such as germplasm work and varietal development. Unless this is achieved, the energies of the few high-level scientists/administrators will continue to be dissipated by ceaseless lobbying for funds.

More All-weather Screenhouses

These are needed to facilitate year-round research activity and redace research turnover time. The Philippines location in the typhoon belt is unique among Asian countries. Typhoons have the effect of reducing field experimentation for all-season crops to only one or at most two seasons per year, where three or even four are possible.

Center Concept

In order to make maximum use of limited resources, the center concept, as a conduit for the allocation and utilization of funds and resources, needs to be seriously considered. Los Baños would be the logical core for this type of center, since the bulk of research manpower and facilities for vegetables are already in place there. The center need not operate exclusively in Los Baños. The present level of funding and manpower, even if increased ivefold, could not support more than one center. Therefore, all attempts to put up more than one center should be resisted.

Interaction in Research with AVRDC and Impact

The most visible contribution of AVRDC to local vegetable research is in the supply of raw and improved germplasm of *Lycopersicon esculentum* and *Brassica campestris* subsp. *pekinensis* (Lour.) Rupr. It should be noted that *Ipomoea batatas*, *Glycine max* and *Vigna radiata* are not considered vegetables in the Philippines. The Philippine Outreach Program (POP), based at BPI-EG, is exclusively devoted to testing of AVRDC varieties and breeding lines.

One variety each of *Lycopersicon esculentum* and *Brassica campestris* subsp. *pekinensis*, developed directly from AVRDC-supplied germplasm, have been approved by the Philippine Seed Board (Table 4). In addition, two open-pollinated varieties of *Brassica campestris* subsp. *pekinensis*, Esperanza and Corazon, are in the seed multiplication and on-farm trial stage. Both varieties are heat tolerant and have moderate levels of resistance to downy mildew and softrot.

Table 4. AVRDC varieties approved by the Philippine Seed Board.

Year	Variety	Pedigree Description
		Lycopersicon esculentum
1987	BPI Tm P-1	Cl. 2784-1-1-4; introduced from AVRDC in 1981; processing type, pH = 4.2, % soluble solids = 6.3, 36 t/ha yield in 7 locations, 2 dry seasons, 16.44% yield advantage over Roma VF check.
		Brassica campestris* subsp. *pekinensis
1983	BPI Vgch-1 (Reyna Elena)	Hybrid no. 62, early maturing, acceptable eating quality, consistent high marketable head yield, uniform size and shape of heads, moderately resistant to softrot.

Source: Seed Board minutes

In terms of training of researchers, AVRDC is perceived to be decentralizing, i.e. recruiting trainees from the provinces and towns instead of from the national centers. The perceived argument behind this trend is that the staff from the national centers are already adequately trained. This, of course, is wishful thinking because it does not consider the turnover factor, which can be quite fast in the Philippines. Very few of the trained people from the regions are actually engaged in substantive research, for the simple reason that operating funds are not adequate. In the absence of expert local guidance and research materials, the few that do research simply test AVRDC technologies.

As a whole, the visible benefits from AVRDC programs in the Philippines are limited. This is not necessarily a reflection of AVRDC inadequacies; perhaps, the country is not fully prepared to benefit from AVRDC.

Priorities for Vegetable Research in the Future

One of the most pressing problems of the vegetable industry in the Philippines is the low consumption of vegetables, estimated at 12.6 kg/capita per year in 1983-84. In contrast, developed countries consume 80.6 kg, while the Asian countries consume only 58.7 kg/capita per year (Grubben 1977).

Even more alarming is the declining trend in per capita consumption between 1973-74 and 1983-84, both in terms of absolute value and percentage of all food crops (Table 5). Considering

Table 5. Per capita consumption of vegetables in relation to all food crops.

Year	Per capita consumption (kg/year)		% vegetables
	Vegetables	All food crops	
1973-74	13.6	252.4	5.4
1974-75	14.8	278.4	5.3
1975-76	14.9	292.1	5.1
1976-77	15.8	299.9	5.3
1977-78	15.8	306.4	5.2
1978-79	14.9	314.8	4.7
1979-80	15.8	314.9	5.0
1980-81	15.5	313.2	4.9
1981-82	15.8	304.8	5.2
1982-83	12.7	292.3	4.3
1983-84	12.6	285.6	4.4

Source. BAEcon 1985.

the importance of vegetables in the diet, these figures are not only alarming from the industry viewpoint, but more importantly, from the nutrition or public health standpoint.

The most urgent need, therefore, is for research to determine the cause(s) of low consumption and ways to stimulate vegetable consumption. Increases in vegetable consumption should trigger developments in the vegetable industry.

Another problem, which probably contributed to low consumption, is the more rapid increase in the prices of vegetable commodities (166.8% between 1977 and 1984) compared to grains (79%), roots and tubers (151.8%), beans, seeds and nuts (131.1%), and fruits (141.2%). This situation suggests problems of high production and marketing costs which should be solved by increasing yield potentials and reducing production and marketing costs.

Varietal development should continue as a high priority for most crops because the use of improved varieties is still the least expensive method of increasing yield and reducing production cost. In some cases, improved varieties are the only effective and practical solution to pest problems.

While increasing yield potential should continue as an important breeding objective, more emphasis should be placed on quality (less deterioration after harvest, processing potential) and resistance to insects and diseases.

Strategies to reduce the use of toxic chemicals need further study. Chemicals not only account for a high percentage of the production costs (59%, 40%, and 23% for cabbage, squash and 'ampalaya' fruitfly, respectively), but also pose health hazards to man and threaten the integrity of the environment. The rampant use of pesticides in vegetable production in the Philippines is well known among consumers and is probably one of the reasons for low consumption of vegetables.

The most destructive insects are noted in the discussion below.

Thrips [*Thrips palmi* Karny and *Megalurothrips usitatus* (Bagnall)]. *Thrips palmi* has drastically reduced melon and watermelon production and is now spreading to eggplant and other vegetable crops. Even tomatoes, which used to be spared, have been reported to be susceptible to thrips (*M. usitatus*) in the major growing areas of processing tomatoes.

Diamondback moth, *Plutella xylostella* (Linn.), is a serious problem for all crucifers. It has been reported in practically all growing areas and many pesticides are ineffective in controlling it.

Fruit borers/worms are even more destructive pests than defoliators or leaf-sucking insects because they cause damage to the marketable product. By the time the damage is recognized, the farmer has already spent most of the production inputs.

The more important insects in this category are: eggplant shoot/fruit borer, *Leucinodes orbonalis* Guenée; tomato/pepper fruitworm, *Helicoverpa armigera* (Hübner); legume pod borers,

H. armigera, *Maruca testulalis* (Geyer), *Etiella zinckenella* (Treitschke); and ampalaya fruitfly *Dacus cucurbitae* (Coquillett).

The most important diseases are discussed below. Bacterial wilt, *Pseudomonas solanacearum* E.F. Smith, has been reported in crops other than the solanaceous family. It has caused serious losses in *Momordica charantia* L. and even in the tropical crucifers. Viruses, such as mosaic of cucurbits, legumes and solanaceous crops, can be controlled traditionally by controlling the vector population. However, some vectors such as white flies are difficult to control.

From an examination of the technical constraints in the Philippine vegetable industry, it appears that research should focus on the following thrusts. Each thrust should emphasize varietal improvement and crop protection more than the other disciplines.

- Off-season production of fresh vegetables;
- Production of processing types;
- Production of temperate types of fresh vegetables in the lowlands;
- Seed production; and
- Integrated pest management.

The suggested thrusts, for each of the important vegetables, ranked according to priority, are summarized in Table 6.

Table 6. Suggested priority areas for research.

Crops	Thrusts[z]				
	A	B	C	D	E
	Priority ranking[y]				
Allium cepa	–	2	–	–	1
A. ascalonicum	3	1	–	2	4
A. sativum	–	1	–	3	2
Brassica campestris subsp. *chinensis*	–	–	–	–	1
B. juncea	–	–	–	–	1
B. oleracea var. *capitata*	3	–	2	–	1
B. campestris subsp. *pekinensis*	3	–	2	–	1
Capsicum annuum	1	3	–	4	2
Citrullus lanatus	–	–	–	2	1
Cucurbita moschata	2	–	–	3	1
Cucumis melo	–	–	–	2	1
C. sativus	3	1	–	4	1
Lagenaria siceraria	2	–	–	3	1
Luffa aegyptiaca and *L. acutangula*	2	–	–	3	1
Lycopersicon esculentum	1	1	–	4	3
Momordica charantia	2	–	–	3	1
Phaseolus vulgaris	2	5	1	4	3
Pisum sativum	2	5	1	4	3
Raphanus sativus	3	–	–	2	1
Solanum melongena	3	–	–	2	1
Vigna unguiculata subsp. *sesquipedalis*	2	–	–	3	1
V. unguiculata subsp. *unguiculata*	2	–	–	3	1
Zingiber officinale	–	1	–	–	2

[z]A = off-season production of fresh vegetables; B = production of processing types; C = production of temperate types of fresh vegetables in the lowlands; D = seed production; and E = integrated pest management. [y]1 = highest priority.

Subregional Cooperation Desired

From the array of research thrusts proposed above, the Philippines can benefit from subregional cooperation in the areas of off-season production of fresh vegetables and integrated pest

management. Both of these are extremely complex problem areas that may require pooling of regional resources to resolve. On the other hand, production of processing types and temperate types of vegetables in the lowlands and seed production can be handled by the country programs if sustained adequate support is provided.

For off-season production, research should consider highly seasonal crops with a steady market, such as tomato and bell pepper. Research components should include varietal development, protective cultivation (including tropical greenhouse design and operation), pest control, postharvest handling and marketing.

For integrated pest management, research emphasis should be concentrated on the above-mentioned pests and diseases. The research areas which can be easily handled using local resources are biological control (using antagonists, parasites, natural enemies and insect pathogens), varietal resistance, pesticidal plants and farming systems.

Research on pesticide development, including hormonal pesticides, is best left to the developed countries, if they still want to pursue it. There are many indications that chemical warfare against pests is a sunset industry.

Role of AVRDC

AVRDC can be perceived as a collector, developer, supplier of "raw materials" and "information broker" in the overall setup of the subregional cooperation. The Center can collect and maintain germplasm of various crops, as well as useful microorganisms and insects. This germplasm can be improved using wide crosses and biotechnology at AVRDC, leaving the utilization aspect to the country programs.

As an information broker, AVRDC can continue to build up a broad collection of literature on vegetables and make this easily accessible to country libraries and individual researchers, public or private. The Center can organize annual scientific meetings among country researchers and promote exchange of scientists. The Center should continue to train high-level researchers to make them capable of conducting independent research. The training of lower level researchers is best left to the country programs.

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PCARRD. Data base of Crops Research Division.

Discussion: Current Status — the Philippines

N.S. Talekar: Seed supply, seed quality and seed availability are major problems in the Philippines. Is anything being done to solve these problems?
R.V. Valmayor: The government is encouraging the private sector to establish vegetable seed companies in the country. Importation of seeds will be phased out for vegetable species where local production is being undertaken. The Board of Investment also awards a tax holiday for seed companies establishing branches in the country.

N.S. Talekar: Why is vegetable production so high in Ilocos and so low in the Visayas?
R.V. Valmayor: The cool and dry climate of the Ilocos provinces from November to early March is very favorable for the production of many vegetables. The Illocos region is the site of two tomato processing factories. On the other hand, Eastern Visayas is frequently visited by typhoons rendering vegetable production very risky. Also, rainfall is rather high during the monsoon months which is not favorable for the production of vegetables.

R.L. Villareal: We have a master plan for vegetable research in the Philippines which is coordinated by PCARRD. However, we don't have a well-defined national production program in vegetable crops. The Home Garden Program and the Commercial Vegetable Production Program carried out by the past administration are no longer being carried out under the present dispensation.
R.V. Valmayor: The present emphasis of the agriculture officials is directed towards dismantling the monopolies which resulted in high cost of production inputs like fertilizers and pesticides, as well as the marketing of commodities like sugar and copra.

N. Amerasinghe: (1) How much of the actual research budget given by the government goes to vegetables? (2) What is the interrelationship? (3) Is there a vegetable master plan?
R.V. Valmayor: (1) In 1988 a total of US$280,000 was given to support 180 studies representing 7% of the total amount devoted to crops. (2) Interrelationships exist through budgetary allocation, research priorities are determined by researchers from different research agencies. Each agency, like UPLB, is responsible to conduct research for a certain discipline to be fine tuned in different regions of the country by the regional cooperating agencies. (3) Yes, there is a national research and development program on vegetable.

R.L. Villareal: There is no organized plan on production but research is well organized.

Question: What is the new vegetable being taken on as a priority crop in the Philippines?
R.V. Valmayor: The white onion is gaining momentum.

P.A. Batugal: In Dr. Valmayor's presentation, sweet potato is not included under vegetables but under root crops, a commodity group which receives a high budgetary allocation. The budgetary allocation for vegetables is thus underestimated.

T.C. Yap: The sweet potato is not as popular as potato due to the lack of publicity. Perhaps AVRDC can compile all the information and publish it in a book form to the general public rather than only among research workers or scientists. This is just a suggestion.

B.T. McLean: AVRDC has held an international symposium on sweet potato and published the proceedings. Although eight years old, these proceedings still contain considerable scientific information; they have just been translated and published in French for francophone Africa. On the other hand, CIP has commissioned an author to write a popular book on the sweet potato.

P.A. Batugal: In reaction to Dr. Yap's comment on lack of information on sweet potato, we in the Southeast Asian Program for Potato Research and Development (SAPPRAD) research and development network (Indonesia, Thailand, Philippines, Sri Lanka and Papua New Guinea) realize this problem. Thus, one of the first projects of SAPPRAD on sweet potato is the documentation of published and unpublished work on sweet potato. This information will be compiled into an abstract volume and made available to all SAPPRAD countries. We hope that this will raise the information and technology level to a higher baseline from which all five countries will start their collaborative work. Recognizing the tremendous work of AVRDC on sweet potato, we would like to seek collaboration between SAPPRAD and AVRDC on this project.
B.T. McLean: AVRDC is currently preparing a proposal for the International Potato Center (CIP) on documentation of sweet potato records and the form of AVRDC collaboration with SAPPRAD is one of the items discussed.

B.M. Legaspi: The Pesticide and Fertilizer Authority approves the pesticides that can be used in crop production and determines those that should be banned. Some banned pesticides are allowed into the country for special purposes like DDT for malaria control. Unfortunately, these banned pesticides still find their way into the farmer's hand as detected by our pesticide laboratory of the Bureau of Plant Industry which conducts residual tests on vegetables taken from market outlets. This is still a problem because BPI has no police power to penalize farmers who use banned pesticides.

R.L. Villareal: I agree with Dr. E.T. Rasco on the decreasing trend of vegetable consumption in the Philippines. However, the figures given are somewhat understimated since consumption of traditional vegetables are not included in the computation.

6

Research and Development of Vegetables in the Rep. of Korea

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Introduction

During the last 12 years, vegetable research and breeding techniques have changed dramatically, along with a significant increase in the area of vegetable cultivation and total amount of vegetable production (Fig. 1). Consumer demand for fresh vegetables has extended to the entire year and the demand for higher quality vegetables has markedly increased. This trend apparently coincided with the higher standard of living achieved through rapid economic growth during this period. The steady decrease in rice consumption and increase in demand for vegetables, especially during the last few years, have resulted in a surplus of rice which consequently arrested efforts to increase rice yields. This conversely stimulated research on vegetables, particularly in the following areas: improvement of cultural practices, off-season vegetable cultivation, mechanization, vegetable marketing, breeding of hybrid cultivars, quality improvement and postharvest technology. These efforts have made meaningful progress and improvements in the vegetable industry in Korea (Tables 1 and 2).

In spite of the rapid expansion of the vegetable industry in Korea, we are also confronting many problems which become increasingly serious with the country's rapid economic progress (HES 1980-87, Kim et al. 1985, Ko et al. 1981, Lee, J.M. 1987, Lee, S.S. 1987, Lee et al. 1982, Pyo 1985). These include: a reduction of income originating directly from vegetable farming; a serious labor shortage; and a diminishing desire to farm because of the unstable market price, low income and uncertain prospects.

The objectives of this report are: to outline vegetable production and consumption in Korea; to describe the historical changes or events which significantly contributed to the development of vegetable production; to analyze and recommend solutions to the problems confronting vegetable production and marketing; and to establish goals for improved vegetable breeding and research, and ways to achieve these goals.

Vegetable Production

Koreans are rather unique in their pattern of vegetable consumption. For example, as presented in Table 3, their per capita production of horticultural crops is extremely high and, just like the Chinese and Japanese, the Koreans are very much dependent on vegetables for sources of horticultural crops (FAO 1984, MAF 1980-86).

Vegetable production statistics are presented in Table 4. Hot pepper is, by far, the leading vegetable in Korea constituting 35.1% of the total vegetable cultivation area, followed by garlic (13.2%), Chinese cabbage (13.2%), radish (10.2%), and welsh onion (6.6%). The large cultivation area of Chinese cabbage and radish is responsible for the high amount of vegetable consumption among Koreans, because these two vegetables are high yielders. Potato and sweet potato, although not officially classified as vegetables in Korea, also have a fairly large cultivation area. Among the fruiting vegetables, watermelons are the most popular followed by oriental melon and strawberry.

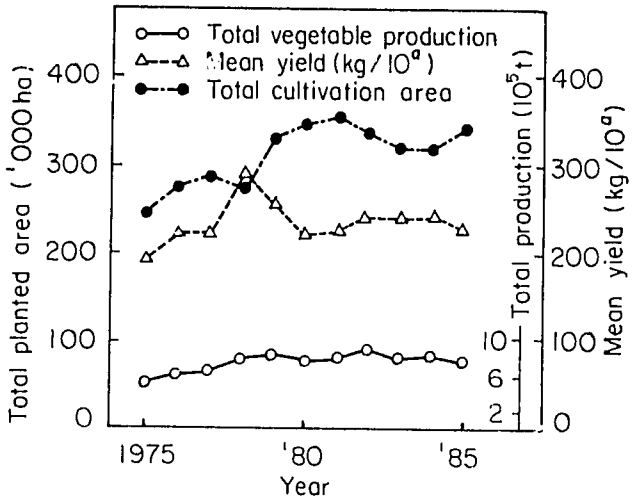

Figure 1.
Changing pattern of vegetable production in Korea, 1975-85.

Table 1. Vegetable production- and marketing-oriented organizations in Korea.

Area	Organizations/Activities
Production	Farmers (agricultural population 19%) and Cooperatives Seed companies (32 in Korea) Fertilizer & chemicals (sales and manufacturers) Machinery and equipment Marketing and processing
Technology and Education	Colleges and Universities Agricultural high schools Experimental stations & Guidance offices National Agricultural Cooperatives (federal and local)
Breeding	Seed companies Horticultural Experiment Station, RDA Universities and Colleges
Academic Societies	Korean Society for Horticultural Science (800 members) Korean Society for Tissue Culture (500 members) Korean Breeding Society (300 members) Meeting for Protected Horticulture (100 members) Cruciferae Meeting (50 members)
Research Funds	Korea Science and Engineering Foundation Korea Research Foundation Ministry of Education, Republic of Korea Rural Development Administration Other foundations (public and private) Universities and Colleges Industries
Government	Promotion of areas for horticultural crop complex Proper management of cooperatives and associations Support for agricultural machineries Free international trade Cultivar registration and marketing Control of vegetable price and production area

Table 2. Classification of published vegetable research papers in the Journal of Korean Society for Horticultural Science, 1979-88.

Subject	No. of papers	1988 RDA[z]
Evaluation of cultivars and new crops	16	16
Cultivation methods	40	40
Seed germination dormancy and propagation	20	
Soil, mulching and fertilizers	9	
Materials for protective structure, etc.	6	
Chemical regulation	5	
Physiology	15	9
Flowering and pollination mechanism	10	
Postharvest physiology	5	
Breeding and seed production	23	13
Breeding methods	6	
Resistance to stresses	5	
Purity and identification	2	
Seed production	3	
Inheritance	7	
Tissue culture	10	8
Quality, maintenance and improvement	7	2

[z]Research projects conducted by the Horticultural Experiment Station, RDA and Provincial RDAs in Korea.

Table 3. Per capita production of horticultural crops.

Country	Vegetables	Fruits	Total	Ratio of vegetables/fruits
	(kg/year/person)			
China	85.0	11.4	96.4	7.46
Indonesia	15.1	23.3	38.4	0.65
Japan	126.3	47.0	173.3	2.69
Korea, Rep. of	225.5	31.3	256.8	7.20
Malaysia	32.5	57.7	90.2	0.56
Taiwan[z]	162.3	84.3	246.6	1.96
Thailand	61.5	81.3	142.8	0.76
Philippines	39.2	131.1	170.3	0.30
USA	118.7	96.1	214.8	1.24

Source: FAO 1984. [z]Data of 1983.

From 1980-86 the cultivation area of cabbage, onion, Welsh onion, garlic, ginger, carrot and watermelon has increased; whereas the cultivation area of radish, potato, sweet potato and cucumber has decreased.

Changes in the area of vegetable cultivation during the last 12 years were apparently influenced by the achievements in vegetable research and breeding activities (Fig. 2). For example, the cultivation area of fall-grown radish and Chinese cabbage steadily decreased, while the cultivation area of the spring-grown crops increased. Among the cucurbits, the cultivation area of watermelon significantly increased and the field-grown oriental melon steadily decreased. The production of hot pepper, the leading vegetable in Korea, has been very unstable. For example, the cultivated area in 1981 was nearly twofold compared to that of 1978, thus, indicating that

Table 4. Vegetable production in Korea, 1980 and 1986.

Type of vegetable	Cultivation area 1980	Cultivation area 1986	Yield/100r 1980	Yield/100r 1986	Total production 1980	Total production 1986
	('000 ha)		(kg)		('000 t)	
Leafy vegetables						
Chinese cabbage	47.8	48.1	6356	7083	3,039.7	3,409.0
Cabbage	2.2	4.1	3326	3494	73.2	141.6
Spinach	6.1	5.1	1183	1229	72.2	62.0
Lettuce	3.2	3.0	1665	1880	53.6	56.1
Condiment vegetables						
Onions	7.7	9.8	3552	3870	274.9	374.9
Welsh onions	16.5	24.2	2749	2526	454.9	612.6
Garlic	37.1	48.2	682	767	225.8	369.8
Hot pepper	132.7	129.0	94	153	125.1	197.8
Ginger	1.9	3.4	869	974	16.6	33.6
Root vegetables						
Radish	48.5	37.7	4964	4525	1,972.7	1,705.2
Carrot	4.0	5.1	1889	1796	75.1	91.7
Potato	37.4	27.7	1193	2040	446.1	565.7
Sweet potato	55.1	27.8	2005	2463	1,013.1	684 0
Fruit vegetables						
Watermelon	15.7	22.6	2133	2135	334.6	483.1
Oriental melon	10.1	5.0	1668	1668	158.9	84.1
Cucumber	4.9	4.0	2128	2128	112.6	85.0
Pumpkin	2.4	2.5	1665	1629	40.1	39.9
Strawberry	8.3	4.1	1018	1065	84.3	43.7
Tomato	1.7	1.1	2827	3093	49.2	34.5

hot pepper cultivation is indeed unpredictable. The cultivated area of garlic has continuously increased and now accounts for about 50,000 ha, placing garlic as the second vegetable crop in Korea.

In general the pattern of vegetable production in Korea is still very unstable, even in some major crops. Improvement of cultural management practices and breeding will ameliorate this situation to some extent but other factors, such as environmental conditions, often have the most important effect on yield and the subsequent price determination of the crops.

The principal pattern of consumption of the five leading vegetables in Korea is illustrated in Fig. 3.

Some researchers in Korea have predicted that the popularity or consumption of kimchi will rapidly decrease with the nation's rapid economic growth, and the consumption of other nutritious vegetables, such as beans, peas, sweet corn and asparagus will increase (Ko et al. 1981). However, the consumption of kimchi has remained nearly constant during the last 10 years, which indicates the very conservative diet habit of Koreans for kimchi. It is worthwhile to mention that kimchi has been exported all over the world.

The unique feature of vegetable production in Korea is the use of protective structures for off-season vegetable production. The frost-free period lasts only between 140 and 240 days, depending upon the location in Korea. Plastic houses and tunnels are the major protective structures for vegetables during winter and early spring. Although one-tenth of the total vegetable cultivation area is being used for this purpose at present (Fig. 4), the area will be steadily increased by about 2,000 ha/year during the next four to six years.

The recent dramatic increase in protective structure cultivation was due to the availability and improvement of supporting and covering materials, improved cultural practices and selection of suitable cultivars. The types of vegetables have also changed, with a significant increase in warm-season crops (fruiting vegetables), such as pepper, tomat oriental melon and eggplant,

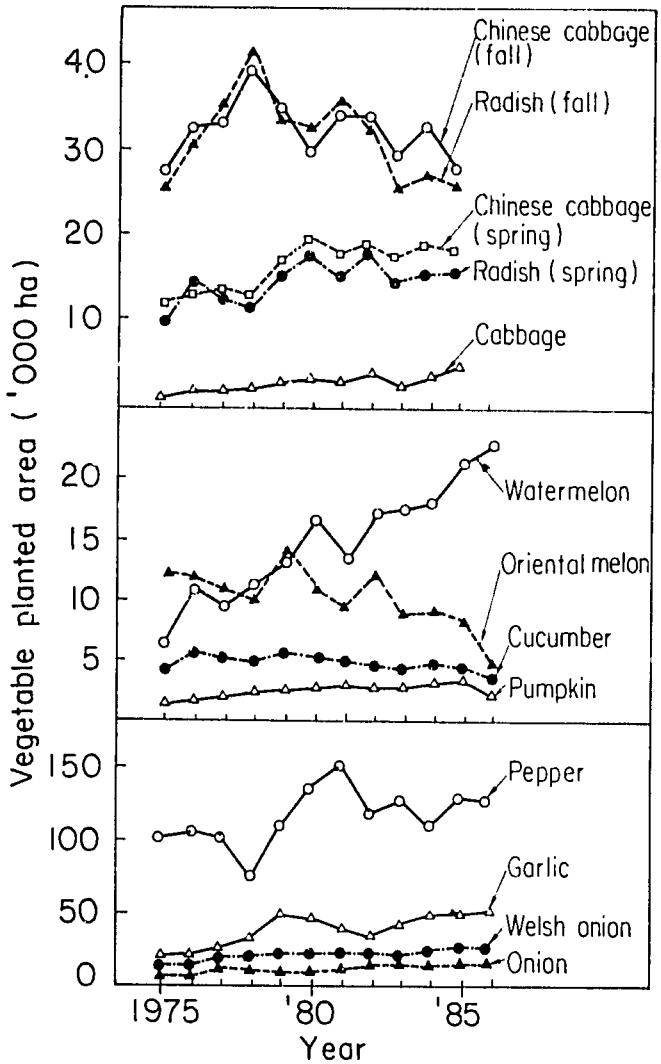

Figure 2.
Patterns of production areas of various vegetables, 1975-86.

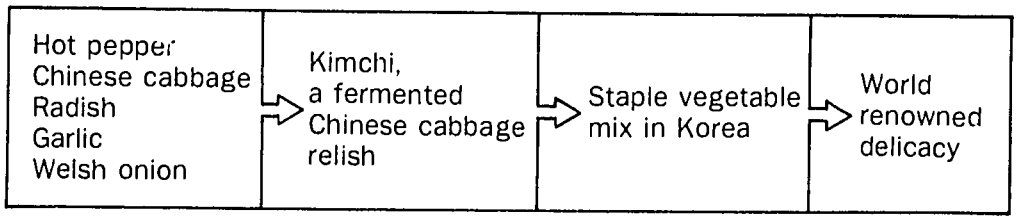

Figure 3. Principal pattern of consumption of five leading vegetables in Korea.

and a decrease in the easy-to-grow leafy and root vegetables. Thus, in some crops, such as strawberry and oriental melons, protective structure cultivation has become substantially larger than the usual field cultivation. Because of the severe limitation of climatic conditions in Korea, protective structure cultivation is very expensive and requires accurate and careful management. Efforts are concentrated to increase yield and quality of vegetables by: using efficient and easy-to-handle housing materials; improving the productivity of soils; engaging in specialized growing such as hydroponics; and breeding of suitable cultivars for indoor cultivation.

Some of the significant historical changes or events which influenced vegetable development in Korea are presented in Table 5. Meaningful progress of vegetable cultivation in Korea took place only recently. The introduction of the first Chinese cabbage hybrid using self-incompatibility mechanism was surely one of the turning points of the vegetable development in Korea; large amount of seeds were previously imported from Japan, either legally or illegally. The establishment of the Asian Vegetable Research and Development Center (AVRDC) and the Korean Subcenter affiliated with AVRDC provided motivation among the young scientists engaged in vegetable research as well as for the vegetable industry. The suspension of the restriction on free international trade of certain agricultural products in 1988 may adversely affect the vegetable industry in Korea.

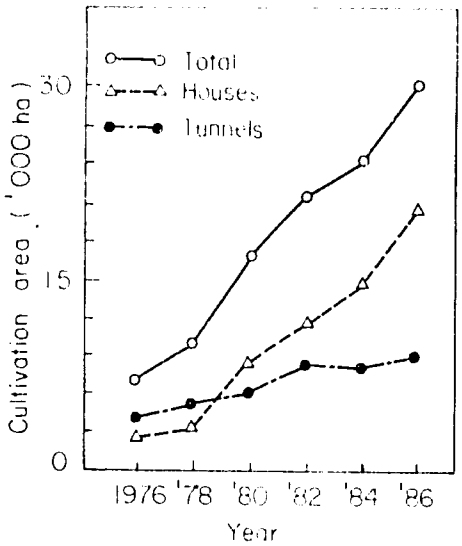

Figure 4.
Changes of cultivation area under protective structures.

Table 5. Historical events which intluenced vegetable development in Korea.

Year	Changes or establishment
1905	Foundation of the Agricultural Demonstration Station
1926	Organization of farmers' union
1930	Establishment and expansion of private seed companies
1939	Success in commercial multiplication of carrot seeds
1941	Foundation of the Association of Seed Companies
1947	Foundation of the National Agricultural Improvement Bureau
1950	Dr. Woo returns from Japan
1953	Importation of onion seeds from USA
1956	Visit of Dr. Macy from University of Minnesota, USA
1958	Active exchange of scholars (University of Minnesota)
1958	Establishment of Nongsawon and appointment of Dr. Woo as the first Director of Horticultural Experiment Station
1959	Dr. Pyo returns from USA
1960	First Chinese cabbage hybrids, Wonye 1 and Wonye 2
1962	Foundation of the Office of Rural Development (ORD)
1962	Introduction of Bulam #1 Chinese cabbage
1973	First export of Chinese cabbage seeds
1974	Inauguration of the Korean Subcenter of AVRDC
1980	Importation of red pepper indirectly from China
1981	Establishment of Agricultural Research Institute
1985	Commercial multiplication of virus-free vegetables
1986	50th anniversary of Heungnong Seed Company
1988	Opening of international trade policy on many horticultural products (24th Olympics)

Source: Pyo 1980, NACF 1985.

Improvement in Production Technology

Some of the major advances in vegetable production technology are listed in Table 6. An approximately 50% yield increase was obtained by establishing planting methods for hot peppers; transplanting seedlings in a high ridged row, mulched with transparent or black PE film. About 30% yield increase of garlic was obtained by mulching and cultivar replacement during the last six years (1980-86). Off-season growing of Chinese cabbage, mostly summer growing in highlands and winter growing in warmer coastal areas, was also very successful.

In spite of these many meaningful advances in vegetable cultivation techniques, our country is still confronted with problems of serious fluctuation in vegetable price, mainly due to either overproduction or shortage of vegetable supply in the market; vegetable supply is dependent upon the climatic conditions and the unexpected changes of cultivation area of particular vegetables. Hot pepper, garlic, onion and spring-grown Chinese cabbage are the major vegetables which exhibit such undesirable price changes. Although the trend during the recent years has been towards stabilizing vegetable production by improving production techniques, through methods such as timely irrigation, efficient chemical control, use of suitable cultivars and rootstocks, etc., there are still many areas which need improvement and further research (Table 6). For example, the fruits of hot pepper become small, short, and seedy as the season progresses, and thus, quality improvement, i.e. maintaining the uniform fruit shape throughout the season, needs urgent attention. The establishment of a summer spinach-growing method is necessary to have enough supply of fresh spinach during summer, when the price is extremely high. The frequent fluctuations in the market price of vegetables, which is the biggest problem in Korea at present, may be controlled partially by international trade of fresh vegetables, release of government funds for price stabilization, and by promotion of industrial storage and processing. Unfortunately, however, we are not ready to enforce any kind of insurance or nationwide contract-growing system for vegetables; thus, the yearly or seasonal fluctuation of vegetable prices will continue for a considerable period with no active or positive means of control.

Vegetable Breeding

Since the introduction in 1960 of the first Chinese cabbage hybrids, 'Wonye 1' and 'Wonye 2', vegetable breeding in Korea has advanced significantly, particularly during the last 10 to 15 years. Excellent cultivars were introduced for most of the major vegetables. Vegetable breeding has contributed substantially to increasing yield and in solving problems arising from various types of cultivation. The list of hybrid vegetables introduced in Korea since 1954 is presented in Table 7. It appears that a stable production of a given vegetable can be obtained 10 to 15 years after the introduction of a hybrid cultivar. Although a precise evaluation of vegetable breeding may not be possible, the recent increase in the export of vegetable seeds provides the proof that vegetable breeding in Korea is indeed very reliable and advanced. For example, Korea exported US$5.4 million worth of vegetable seeds in 1986 compared to an import of US$2 million (Table 8). Most of these seeds were exported to Japan.

Recently, many private seed companies began focusing their special efforts in developing hybrid cultivars only for export. However, the seed companies are facing problems of a serious labor shortage and high labor cost in multiplying their original inbred lines, especially in radish and some other cruciferous crops. Several seed companies are equipped with modern facilities and have also installed large-scale CO_2 treatment facilities to partially overcome the self-incompatibility. In addition, other treatments, such as electrical shock, spray of NaCl and other salts, temperature treatment, etc. are being practiced and/or evaluated to replace or further increase the CO_2 effect. These companies are also maintaining very close relationships with universities and the Horticultural Experiment Station, and they are eager to obtain technical support.

The number of vegetable cultivars registered in Korea is given in Table 9. The number may not be impressive compared to some other countries (e.g. 4,000 in Japan). However, the

Table 6. Progress in vegetable cultivation techniques and research areas which need immediate improvement.

Type of vegetable	Major progress	Further research or improvement needed
Overall	Successful chemical control including herbicides High density planting Establishment of growing methods under protective structures	Mechanization Irrigation systems Multiple protection
Pepper	Cultivar selection Chemical control	Canopy control Quality improvement
Garlic	Mulching and high density planting Cultivar selection	Control of secondary growth
Chinese cabbage	Off-season growing Cultivar selection	Irrigation Mineral nutrition Control of premature bolting
Melons	Fruit setting Rootstock research	Quality improvement
Welsh onion	Cultivation methods (seeding and transplanting)	Yield increase
Onion	Fertilization	Control of premature bolting Yield increase
Carrot	Planting dates and location	Off-season growing and storage
Spinach	Spring growing	Summer growing Slow bolting
Strawberry	Successful forcing	Yield increase Quality improvement

Source: HES 1980-87, Kim et al. 1985, Ko et al. 1981, Lee et al. 1982, Park 1983.

Table 7. Prominent hybrid cultivars introduced in Korea from 1954-81.

Year	Kind of vegetable	Cultivar	Significance of introduction
1954	Cucumber	Jinjukyobae 1	First hybrid by Korean breeder
1960*	Chinese cabbage	Wonye 1 and 2	Use of self-incompatibility
1962*	Onion	Wonye 1 and 2	Use of male sterility
1963	Chinese cabbage (spring)	Choonpakyulgu	First spring-type cultivar
1965*	Radish (spring)	Bulamdaehyungbommu	First spring-type cultivar
1969*	Chinese cabbage	Haekbaechu	Interspecific hybrid with *B. napus*; disease resistant
1969*	Pepper	Bulamhouseput	World's first F_1 by use of male sterility
1971*	Pumpkin	Bulamsachulae	Dwarf-type developed by interspecific hybridization
1974	Cabbage	Dongchoon (1962)	First cabbage hybrid
1974	Radish	Choonchualtari	First altari-type hybrid
1974*	Pepper	Saemaeulkeumjang	First dry-type hybrid
1976	Cauliflower	Snow Ace	First cultivar in Korea
1978	Radish	Keumjinju	Breeding through male sterility
1981	Pepper	Hongilpoom	Resistant to blight

*Of particular importance. Source: Lee, J.M. 1987, Lee, S.S. 1987, Park 1984, Pyo 1980.

Table 8. Korean export of vegetable seeds, 1986.

Type of vegetable	Quantity (liter)	Amount (US$)	Remarks
Radish	266,139	3,623,896	Domestic hybrid
Chinese cabbage	33,797	406,247	Domestic hybrid
Cucumber	9,774	348,165	Contract
Welsh onion	35,450	241,121	Domestic hybrid
Carrot	57,182	139,390	Contract
Watermelon	4,145	122,736	Contract
Others	103,042	555,461	Contract
Total	509,529	5,437,016	

Table 9. Vegetable cultivars registered in Korea, 1988.

Type of vegetable	No. of fixed cultivars	No. of hybrid cultivars	Total no. of cultivars
Radish	20	171	191
Chinese cabbage	8	175	183
Cabbage	0	7	7
Pepper	5	102	107
Tomato	1	37	38
Cucumber	2	109	111
Oriental melon	1	34	35
Watermelon	1	71	72
Pumpkin	1	47	48
Welsh onion	5	12	17
Onion	7	19	26
Carrot	5	22	27
Lettuce	5	0	5
Spinach	7	14	21
Total	68	820	888

procedure for cultivar registration in Korea is very unique and restrictive. The new cultivar must have a clear identity and should pass two or three field performance tests at different locations. At least one of the tests must be an official test conducted directly by the staff of the Horticultural Experiment Station of the Rural Development Administration (RDA). The figures in Table 9 do not include cultivars intended only for export. There are more than 100 hybrid cultivars introduced in radish, Chinese cabbage, pepper and cucumber; more than 30 hybrid cultivars are registered in tomato, oriental melon, pumpkin and watermelon. These will later increase very rapidly because more than half of the cultivars were registered after 1980. With the rapid development of off-season protective cultivation, it is urgently required that many cultivars having distinctive characteristics should be developed for each growing type in Korea.

Some of the major breeding objectives for individual vegetables in Korea are presented in Table 10. Breeding for disease resistance is, by far, the most common objective followed by quality improvement and high yield. To be more specific, the dried hot pepper should be high in capsaicin content (pungency) and the red pigment, capsanthin, should easily diffuse into the liquid portion of kimchi. Farmers do wish to have heat-tolerant summer Chinese cabbage with slow-bolting habit and resistance to bacterial softrot. Early-maturing and high-yielding onion cultivars are also urgently needed. The parthenocarpic habit of cucumber, watermelon, tomato, pumpkin and oriental melon should be incorporated into the established lines or cultivars to satisfy the requirement for growing under protective structures.

The agricultural application of biotechnology is attracting the attention of horticultural students and young scientists as an efficient way of improving vegetable cultivars (Kang et al. 1986).

Table 10. Major breeding objectives of vegetables in Korea.

Vegetable	Major breeding objectives
Hot pepper (dry)	Disease resistance, high yield, stress tolerance, suitability for mechanical harvest
Hot pepper (green)	Low temperature tolerance, disease tolerance, high quality
Radish (spring and summer)	Heat tolerance, high quality
Chinese cabbage (spring and summer)	Heat tolerance, earliness, slow bolting
Cabbage	Diversity, heat tolerance, crack resistance
Spinach	High yield, disease tolerance, slow bolting
Onion	Earliness, storage type, disease resistance
Welsh onion	Purity and uniformity
Oriental melon	High quality, less physiological disorder
Melon	High quality, disease resistance, storage type
Watermelon	Disease resistance, high moisture tolerance, high quality
Cucumber	Parthenocarpic, high yield, disease tolerance
Pumpkin	Low temperature tolerance, dwarf type, high yield
Garlic	Virus-free, seed breeding

Source: Lee, J.M. 1987; Lee, S.S. 1987

There have been a few cases of practical application. For example, virus-free plants of potato, strawberry and garlic are now commercially available at reasonable prices. Interspecific hybrids are being extensively developed by means of fertilized ovule culture to add diversity to parental inbred lines, especially in Cruciferae, Solanaceae and Cucurbitaceae. Anther culture, which is the most promising for rapid application to breeding, can shorten the duration of conventional breeding and is widely utilized by many researchers in Korea. Anther culture of interspecific hybrids (such as *Brassicoraphanus*) is being performed successfully and may add useful gene sources to the existing inbred lines (RDA 1985). Research on the production of artificial seeds, protoplast fusion and gene manipulation through vector systems are now underway in many universities, research stations and seed companies. Rather generous allocation of research funds to these areas tends to aggravate this overheated attraction in Korea (Park 1984, Withers and Alderson 1986).

Prospects of the Vegetable Industry

It is expected that Korea will be able to achieve a remarkable national economic growth in the near future. A doubling of the present per capita GNP of US$3,000 is expected by 1992 (KRIAE 1985). The percentage of the population engaged in agriculture will decrease from the present 18.5% to 5% to 7% by the year 2000, along with a serious reduction in income originating directly from farming. In spite of the rapid economic development and expected increase in vegetable consumption, a similar pattern of vegetable consumption will be maintained and the demands for higher quality vegetables, as well as for processed vegetables, will greatly increase. The cultivation area of hot pepper and cruciferous crops will decrease and the protected structure cultivation area will rapidly increase. Marked yield increase is expected through breeding of better cultivars, wise selection of cultivars, and application of advanced production techniques. Breeding will become increasingly important in Korea and export of vegetable seeds will increase. In addition, the following changes are expected in the vegetable industry: crop specialization; increase in farm size; development of specialized production techniques for minor vegetable crops, such as perilla, bellflower, leeks, the root of *Codonopsis tanghen* Oliver, celery, sprouts, mushrooms and others.

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Discussion: Current Status — the Rep. of Korea

R.L. Villareal: What are the key factors that contributed to the success of your vegetable seed industry in Korea?
J.M. Lee: In this regard, there was a paper presented by H.G. Park in the Symposium held at the National Chunghsing University in December 1986. One of the key factors is the role of the Horticultural Experiment Station in supporting the private sector through genetic materials, technology and trained man power during the early 1950s.

N.S. Talekar: Why is the yield/ha of vegetables going down?
J.M. Lee: It is mainly due to the relative reduction of the Chinese cabbage and radish cultivation area and increase in the area of other vegetables. The yield of Chinese cabbage and radish is much higher than other vegetables.

R.M. Nor: (1) What vegetable types are commonly grown under protective cover? (2) What sort of yield advantage is obtained as compared to open cultivation? (3) What are the main reasons for the high yields?
J.M. Lee: (1) Oriental melon, strawberry, Chinese cabbage, cucumber, pepper and radishes; (2) A 50% increase in yield is obtained in fruiting vegetables. If duration is lengthened, an increase of up to 400% may be achieved. (3) A 50% increase is achieved, mainly by providing the crop with the environment for intensive cultivation.

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7

Vegetable Production and Policy in Malaysia

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Introduction

Malaysia has an area of 320,000 km², is situated between 1°N and 7°N latitudes, and is bordered by Thailand on the north, Singapore on the south and Indonesia on the east and west. The landscape is generally undulating with the flat lands normally confined to the coastal areas. It has a population of 16.17 million, comprised mainly of, Malay, Chinese and Indian ethnic backgrounds.

Malaysia is basically an agricultural country with about 36% of the population involved in agricultural activities. Agricultural produce contributes about 22% of the country's GDP, valued at US$4,974 million (exchange rate of US$1.00 = M$2.62). The major agricultural crops are rubber, oil palm, rice and cocoa (Table 1), and the main agricultural exports are rubber, oil palm, cocoa, timber and pepper. Food crops such as vegetables, maize and legumes are cultivated to a much lesser extent than the export crops.

Table 1. Acreage of crops in Malaysia, 1980-85.

Crop	Year					
	1980	1981	1982	1983	1984	1985
	(ha)					
Rubber	2,004,670	2,006,070	2,005,840	1,971,260	1,978,680	1,959,000
Oil palm	1,023,304	1,117,900	1,182,800	1,253,000	1,349,300	1,464,900
Cocoa	123,800	158,800	193,500	215,100	242,000	258,000
Rice	735,215	767,640	758,400	769,750	769,750	775,220
Coconut	349,400	318,000	319,000	324,000	298,000	274,000
Pepper	12,720	13,405	12,800	11,360	10,500	10,100
Pineapple	12,180	11,600	10,610	11,050	10,620	10,250
Fruit	93,000	87,800	89,000	90,000	92,000	94,000
Tobacco	12,450	14,290	9,570	9,440	9,310	9,130
Vegetables	12,800	12,520	7,460	7,620	7,830	8,090

Source: GOMa 1986.

Current Status

Vegetable Area

The area under vegetable cultivation in peninsular Malaysia fluctuates between 7,000 and 12,000 ha annually. More than 2,000 ha is situated in the highlands which exceed 1,500 m elevation above sea level. Vegetable areas in the east Malaysian states of Sarawak and Sabah consist of about 1,000 and 2,000 ha, respectively. The states of Johor, Pahang, Kelantan, Perak, Selangor, Melaka and Penang constitute about 85% of the total vegetable growing areas in the country. The distribution of vegetable growing areas for peninsular Malaysia is shown in Table 2 and Figure 1. Although large tracts of land are suitable for vegetable cultivation, these are being used for other crops or activities.

Table 2. Main vegetable production areas in peninsular Malaysia.

State	Districts	Area (ha)[2]
Johor	Tangkak, Kulai	3,230
Panhan	Cameron Highlands, Bukit Tinggi and Gambang	2,250
Kelantan	Cabang Empat and Kota Bharu	1,130
Perak	Lembah Kinta, Hilir Perak and Batang Padang	730
Selangor	Banting, Kuala Selangor	710
Melaka	Tanjong Minyak	330
Penang	Pinang Tunggal	320

[2]The annual average cultivated area between the years 1971 and 1981. Source: MARDI 1984.

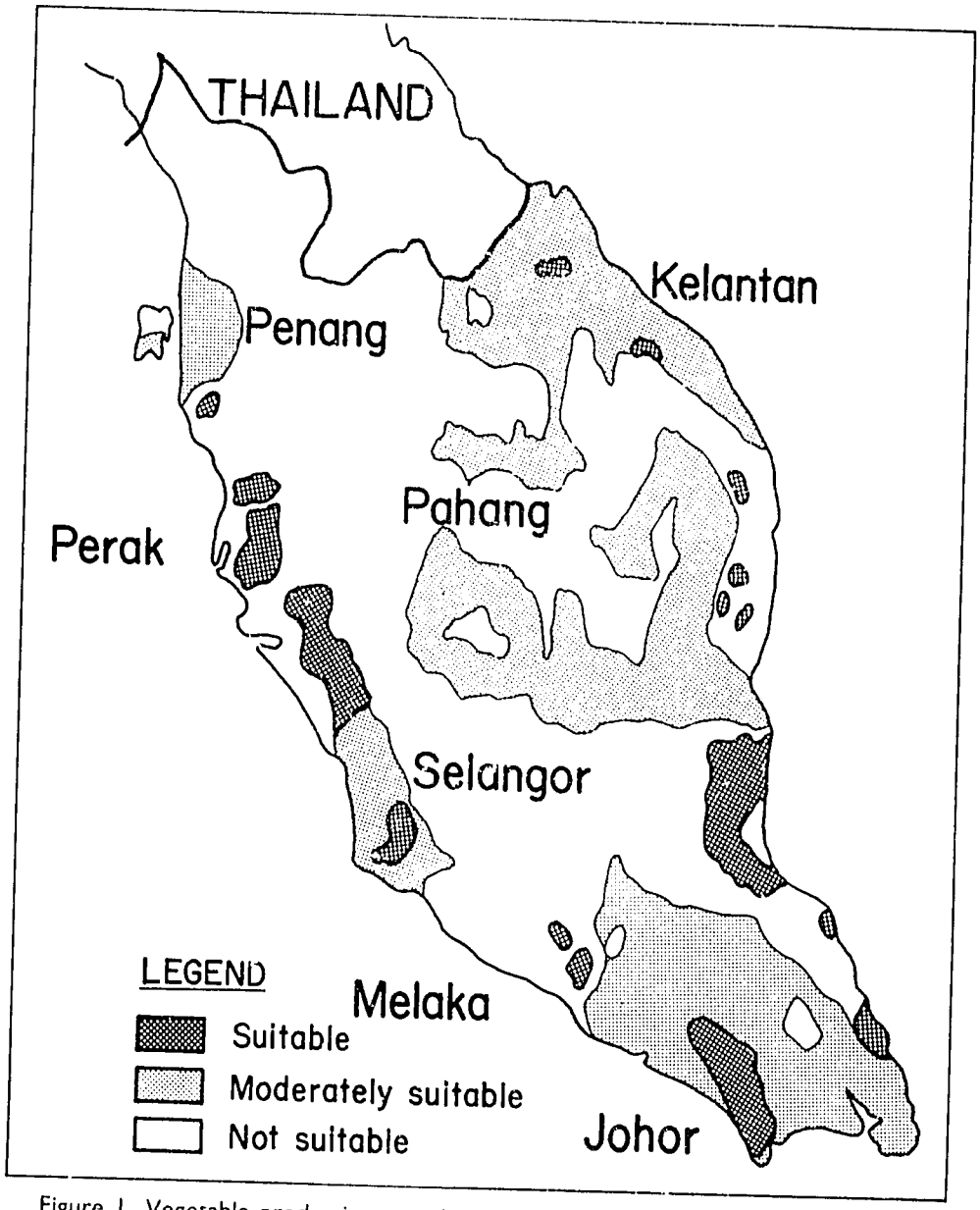

Figure 1. Vegetable production area in peninsular Malaysia. (Source: MOA 1984)

Supply and Demand

Malaysia produces about 480,000 t of vegetables annually. This exceeds the domestic requirement by about 15% and the surplus is exported, mainly to Singapore. In 1983 almost 85,000 t of fresh vegetables were exported to Singapore, valued at about US$12.6 million. Exports to Singapore, however, have been declining and in 1985, the value was only US$10.3 million (Table 3).

More than fifty types of vegetables are grown in Malaysia, but the main ones are Chinese mustard, cabbage, chili, tomato, long bean, cucumber, water convolvulus, bitter gourd, ginger, eggplant, spinach and loofah. The acreage of each vegetable is shown in Table 4. The major vegetables exported to Singapore are chili, Chinese mustard, tomato and fruit and leafy vegetables (Table 5).

Although Malaysia produces sufficient fresh vegetables for local consumption, she still imports a substantial amount of temperate and processed vegetables. It is estimated that about US$68.6 million worth of vegetables, excluding dried beans and mushrooms, are imported annually. The most frequently imported vegetables are onion, shallot, garlic, cabbage, chili, Irish potato and processed vegetables (Table 6). These vegetables are imported because either they are produced in insufficient quantities, are unsuitable for growing or uneconomical to produce in Malaysia.

The current demand for vegetables in peninsular Malaysia is estimated to be 400,000 t annually and the amount projected for the year 2000 is about 600,000 t. The projected demand for each vegetable in the year 2000 is given in Table 7. The current demand for Irish potato is about 47,000 t and this amount is expected to increase to more than 100,000 t by the year 2000.

Vegetable production in Sabah in 1982 was estimated to be around 19,000 t (MOA 1984), of which about 7,000 t was from highland and 12,000 t was from lowland areas. Sabah exported about 1,500 t of vegetables in 1982 and imported around 9,000 t in the same year. It is

Table 3. Malaysian vegetable export.

Type of vegetable	1983		1984		1985	
	Quantity (t)	Value (US$'000)[2]	Quantity (t)	Value (US$'000)	Quantity (t)	Value (US$'000)
Vegetables, frozen	1	0.46	7	14.12	6	10.76
Vegetables preserved in brine	23	4.35	6	4.31	1	1.26
Vegetables, other dried leguminous shelled	173	49.77	51	18.93	46	17.29
Tomato, fresh or chilled	7,253	1,222.71	7,059	945.80	6,986	943.09
Garlic, fresh or chilled	577	530.94	1,881	505.88	476	302.33
Onion, excluding spring onions, fresh or chilled	6,580	1,913.40	5,553	1,467.90	16	4.16
Shallots, leeks and other alliaceous vegetables, fresh or chilled	–	–	6	0.61	3,952	473.28
Cabbage, fresh or chilled	4,195	678.74	4,443	602.40	3,952	473.28
Mushrooms, dried	4	33.36	6	23.09	4	18.46
Mushrooms in airtight container	96	115.53	37	53.44	40	49.77
Chilies, fresh	5,623	1,329.50	5,407	1,165.34	7,316	1,365.84
Chilies, dried	98	78.78	63	69.92	83	66.83
Chilies, ground	1	3.24	2	3.74	4	8.05
Other vegetables, fresh or chilled	60,180	6,722.90	63,654	6,161.83	69,442	6,448.24
Total	84,804	12,683.58	88,175	11,037.31	92,324	10,182.58

[2]US$1.00 = M$2.62. Source: MOA 1986a.

Table 4. Area of vegetable production in peninsular Malaysia, 1986.

Vegetable	Acreage (ha)
Cabbage	987
Chinese mustard	1,246
Chili	1,500
Cucumber	1,249
Tomato	652
Okra	747
Long bean	1,640
Eggplant	569
Ginger	496
Water convolvulus (kangkong)	447
Bitter gourd	376
Spinach	207
Loofah	527
Sweet potato	1,588

Source: MOA 1986b.

Table 5. Volume and value of vegetables imported by Singapore, 1983.

Vegetable	Amount (t)	Value (US$)[z]	Malaysian export (t)	Value (US$)	Malaysian export (%)
Cabbage	16,432	4.50	4,405	0.73	24
Chili	5,703	1.41	5,540	1.22	97
Chinese mustard	2,022	0.23	2,019	0.23	99
Tomato	7,865	1.68	7,373	1.22	93
Other leafy vegetables	19,045	3.02	15,871	2.52	80
Other fruit vegetables	43,806	4.50	43,114	3.82	98
Root vegetables	7,835	1.37	6,367	0.42	81
Bulb vegetables	53,407	16.87	6,004	2.29	16
Rhizomatous vegetables	13,696	2.25	7,194	0.53	52

[z]US$1.00 = M$2.62. Source: MTCS 1984.

Table 6. Volume and value of vegetables imported by peninsular Malaysia, 1984-86.

Vegetable	Volume (t)			Value (US$'000)[z]		
	1984	1985	1986	1984	1985	1986
Onion/Shallot	92,500	88,900	89,100	22,901	20,344	20,802
Beans, dried	54,100	42,600	107,400	19,618	12,443	14,695
Potato	45,000	45,200	46,000	8,931	7,710	8,092
Cabbage	33,500	32,500	21,100	4,886	4,084	3,053
Garlic	20,000	16,500	22,700	12,595	10,458	12,405
Mushrooms	730	1,300	997	8,397	9,962	10,687
Tomato	5,600	9,000	5,300	2,824	2,099	2,672
Chili	16,000	18,000	24,000	11,450	11,641	10,115

[z]US$1.00 = M$2.62. Source: GOMb 1986.

Table 7. Vegetable demand in peninsular Malaysia.

Vegetable	Demand (t)	
	1984	2000[z]
Chinese mustard	46,000	69,000
Long bean	39,000	58,000
Cucumber	39,000	57,000
Cabbage	33,000	49,000
Eggplant	29,000	43,000
Chili	28,000	33,000
Tomato	22,000	33,000
Water convolvulus	21,000	32,000
Spinach (*Amaranthus*)	n.a.	32,000
French bean	16,000	22,000
Okra (lady's finger)	13,000	20,000

[z]Projection Source: MARDI 1984.

estimated that the total annual requirement for vegetables in Sabah is 25,000 t. The per capita consumption is estimated to be about 24 kg per person per year.

Sarawak imported around 11,000 t of vegetables in 1982 valued at US$4 million. Information on local production, however, is lacking.

Socio-economic Status

In order to have a better insight into the vegetable industry in Malaysia, an agro-economic survey of the industry in peninsular Malaysia was carried out by MARDI in 1981. The results of the survey indicated that the majority of vegetable farmers in the lowlands were ethnic Chinese (60%), followed by Malays (37%) and others (3%) while in the highlands, 81% were Chinese, 18% Indian and 2% others. The farm size per household ranged between 0.8 and 1.2 ha for the lowlands and averaged 0.7 ha in the highlands. The family size was about 4.8 persons per household. Many vegetable growers used their own or family labor, especially in highland areas. The national average for labor utilization in vegetable production was 1,247 mandays per ha per annum. Most of the farmers were above 45 years of age and many of them had at least 15 years of experience in vegetable production. About 49% of the farmers were owner operators (mostly Malays), while 19% were tenants. The rest were illegal cultivators on government land. The returns obtained from vegetable farming, however, depend on the vegetable types planted and the price offered (Tables 8 and 9).

Role of Vegetables in Nutrition

Malnutrition is not a problem in the country, though isolated cases do exist. Nutritional deficiency is also encountered. The nutritional problems appear to be associated with several factors, namely the level of literacy, family income and food taboos.

Qureshi (1987) reported that the availability of total dietary energy for Malaysians exceeded the normative requirement (2500 kcal) and the per capita protein intake is sufficient (58 g/day). However, the amount for fat is below the level required while that for sugar is very high (86 g/day). Vegetables contributed only 4% of the protein requirement, with the main supply coming from fish. Malaysian consumption of fruits and vegetables constitutes only 3.7% of the diet. The vegetables consumed comprise both modern and traditional types. Many of the traditional vegetables contain high levels of protein and essential amino acids. Popular traditional vegetables include *Souropus androgynus* ('cekur manis'), *Champeria griffithii* ('cemperai'), *Parkia speciosa* ('petai'), *Pithecellobium lobatum* ('jering'), *Sesbania grandiflora* ('turi') and papaya shoot. Their

Table 8. Cost and return for some highland vegetables per hectare.

Vegetables	Gross return (US$)[2]			Material cost (US$)	Labor return (US$)		
	Previous season	Highest	Lowest		Previous season	Highest	Lowest
Cabbage	7,629	9,890	3,860	2,189	5,439	7,701	1,670
Cauliflower	18,641	25,107	10,664	9,542	9,099	15,565	1,122
Bell pepper	8,336	9,618	5,258	2,663	5,673	6,956	2,595
Tomato	8,015	9,886	3,893	1,961	6,055	7,925	1,932

[2]US$1.00 = M$2.62. Source: MARDI 1983.

Table 9. Cost and return for some lowland vegetables per hectare.

Vegetable	Gross returns (US$)[2]			Material cost (US$)	Labor return (US$)		
	Previous season	Highest	Lowest		Previous season	Highest	Lowest
Spinach	3,530	4,350	2,235	12,691	2,261	3,081	966
Water convolvulus	3,847	4,811	2,980	1,497	2,350	3,315	1,484
Cabbage	5,771	9,242	4,349	972	4,798	8,270	3,377
Chinese mustard	4,114	5,433	2,710	1,077	3,045	4,356	1,633
Cucumber	4,798	5,810	3,226	1,781	3,016	4,029	1,444
Long bean	3,326	4,425	1,829	1,294	1 825	2,925	329
Chili	10,064	12,432	7,629	1,336	8,728	11,096	4,003
Tomato	5,835	6,357	3,314	1,113	4,722	5,252	2,201
Ginger	9,683	15,296	8,255	1,738	7,945	13,558	6,517

[2]US$1.00 = M$2.62. Source: MARDI 1983.

protein contents range between 5.9% and 9.1%. The villagers and low income groups either grow the traditional vegetables themselves or spend relatively more money on the purchase of these vegetables compared to the modern ones (Zanariah et al. 1986).

Incidences of malnutrition and nutritional deficiency have been reported more in rural than in urban areas. In one village in Terengganu, malnutrition has been reported to be as high as 30%. Nutritional deficiency is observed to be more common among those who have strong beliefs or taboos against consumption of certain foods. Many vegetables and fruits are believed to have a 'cool or wind effect' while meat could cause a 'hot effect'. Consequently many avoid taking nutritious vegetables, fruit or foods and this has led to vitamin A and B deficiencies, anemia, skin diseases and other nutritional disorders.

National Policy on Vegetables

The National Agriculture Policy (NAP) was launched in 1984. NAP has stressed that vegetable production will be upgraded to meet increasing local demand and export markets. Increased production will be made through increased productivity from existing areas as well as opening up new areas (MOA 1984).

Vegetable cultivation will become more organized, preferably on a commercial scale using modern technologies to ensure efficient production and quality produce. More land will be allocated for vegetable production, particularly near town centers or marketing centers and in the highlands.

In order to ensure the implementation of the policy the government has introduced various incentives, namely pioneer status, tax exemptions, export allowances and credit facilities. All agencies responsible for upgrading the industry have been directed to step up their role, including research by MARDI, extension and seed production by the Department of Agriculture, marketing

by the Federal Agricultural Marketing Authority (FAMA) and provision of infrastructure by the Drainage and Irrigation Department (DID) and FAMA.

Research on Vegetables

The main research institute in Malaysia conducting vegetable research is the Malaysian Agricultural Research and Development Institute or MARDI. There are at least 24 senior scientists directly involved in various research disciplines ranging from breeding to postharvest handling and processing and marketing (Table 10).

Table 10. Manpower distribution in vegetable research in MARDI, 1988.

Discipline	No. of scientists[z]
Breeding	4
Agronomy/LVT[y]	9
Pathology	3
Entomology	2
Physiology	1
Postharvest/processing	1
Economics	0
Water management	1
Agricultural engineering	0
Crop nutrition	2
Weed science	1
Total	24

[z]Directly involved. [y]LVT = local verification trial.

The overall objective of vegetable research in MARDI is to develop appropriate and efficient technologies to increase productivity as well as to increase the income of producers. Some of the specific objectives are:

- To develop superior and resistant planting materials which are able to meet quality requirements and are adaptable to the growing environments as well as high yielding;
- To formulate efficient production techniques under various scales of production and efficient management systems to obtain high productivity and quality and prevent crop losses due to pests and diseases; and
- To develop efficient postharvest handling and processing techniques to ensure quality produce and high return to producers.

Vegetable research by other institutions is minimal. Some research is conducted at the Agricultural University of Malaysia (UPM), the University of Malaya (UM) and the National University of Malaysia (UKM). Few staff are involved and most of them are engaged part-time.

About US$75,000 is allocated annually for vegetable research in MARDI under operating expenses. Facilities for research are considered sufficient except for certain equipment such as those for postharvest handling and processing and farm machinery.

Vegetable Industry Constraints

The development of the vegetable industry lags behind that of industrial crops like rubber, oil palm and cocoa. This is due mainly to the fact that vegetable cultivation is a high-risk enterprise beset with many problems. Some of the constraints in the industry follow.

Lack of High-yielding, Quality, Pest- and Disease-resistant Varieties

Until recently most farmers grew local or unselected introduced varieties which resulted in crops of low yield, poor quality and susceptibility to pests and diseases. The chili and tomato cultivars grown are susceptible to bacterial wilt, viral diseases, late blight and anthracnose while local cultivars of long beans and cucumber not only produce low yields but have poor keeping quality.

Low Level of Crop Management Practices

The low yield of vegetables obtained in Malaysia is also the result of the low level of crop management provided in terms of cultural practices, fertilizer application, water management and pest control. This phenomenon can be attributed to the prevalence of illiteracy among the vegetable growers (34%-52%), ineffective extension services and lack of appropriate technology.

Pests and Diseases

Pests and diseases still pose major problems in vegetable cultivation. In the national survey, 85% of the farmers reported these as a problem and about 65% used pesticides to control them. Some of the most important pests and diseases of vegetable crops are viruses of chili and tomato, *Plutella* and *Hellula* of cabbage, rust of long bean and French bean, bacterial wilt of chili and tomato, soft rot of cabbage and early and late blight of tomato.

Seed Supply

Sources of seed supply are mainly from seed merchants (52%), the Department of Agriculture (7%) and farmers' own plots (Suffian and Chua 1985). The main problems of seed supply are lack of good quality seeds (true to types, high viability, etc.), limited supply, inconsistency and timeliness of supply, untested or unproven cultivars and poor distribution system. These problems have hampered the development of the vegetable industry.

Most of the imported vegetable seeds come from Thailand (50%), Taiwan, China (25%) and China (25%). The level of import of vegetable seeds into Malaysia for 1983 and 1984 is shown in Table 11. Some of these vegetable seeds could be produced locally, but the lack of expertise, unsuitable environment, absence of inbred lines, and relatively high production costs have discouraged local production.

Table 11. Vegetable seed import into peninsular Malaysia, 1983-84.

Vegetable species	Amount (t)	
	1983	1984
Amaranthus gyanticus	34.1	29.0
Apium graveolens	11.5	10.5
Brassica spp.	122.1	137.4
Chrysanthemum coronarium	5.9	14.1
Coriadrum sativum	14.1	20.0
Cucumis sativus	6.1	11.6
Hibiscus esculentus	11.0	20.5
Ipomoea reptans	178.3	305.7
Latuca sativa	14.5	17.7
Phaseolus vulgaris	13.1	20.1
Raphanus sativus	12.2	31.1
Vigna sinensis and V. sesquipedalis	98.6	122.9
Others	53.3	62.6
Total	574.8	803.2

Source: Suffian and Chua 1985.

Postharvest Handling and Processing

Losses of from 20% to 30% of the vegetable produce before reaching consumers are common. This is due to the lack of application of postharvest handling techniques such as cleaning, sorting or grading, storage, packaging and transportation. FAMA and MARDI have developed a grading system and standardization for some vegetables to reduce such losses and to maintain quality. There are 24 cold rooms in the country, each with a capacity of 10 t or 20 t, but they are not utilized fully and require certain modifications (e.g. to the existing temperature and humidity control systems).

Marketing

Commercial vegetable production should be planned in line with the marketing strategy. Usually, this aspect has not been given emphasis and consequently leads to marketing problems. About 48% of the respondents in the national vegetable survey reported this as a problem. Marketing problems encountered include failure to sell produce at reasonable prices, price fluctuations, lack of transportation, infrastructure and market information. These problems can also be attributed to the currently unorganized nature of vegetable production.

Lack or Support Services

Food production has not been given high priority in the past. Thus, infrastructures, extension services, credit, marketing and other support services have not been sufficiently catered for.

Future Directions

Vegetable Requirements

Based on the current population growth rate of 2.5%, per capita vegetable consumption of 47 kg per annum and average vegetable production of 40 t per hectare per year, it is estimated that about 600,000 t of vegetables will be required by the year 2000. By assuming an export potential of 25% to 30%, the total demand for vegetables in the year 2000 will be around 800,000 t. This will require a production area of about 20,000 ha. In addition, 5,000 ha in Sabah and 3,000 ha in Sarawak are required to produce vegetables for local consumption and export.

Support Services

For acceleration of growth in the industry, certain prerequisites are essential. These include appropriate technologies, infrastructures, credit and finance, seeds, extension, marketing and appropriate government policies. Some technologies might be difficult to develop and these include mechanization, development of resistant varieties and quality produce. A longer research period is needed. However, land problems, postharvest handling, processing and finance could be resolved within a relatively shorter period. The extension services, however, need upgrading and improvement while marketing requires special emphasis.

Program Development

Although the demand and the support services to be provided for the vegetable industry may induce growth, real development may not take place unless certain strategies and development programs are implemented. The programs should be geared to achieve the following objectives:

- to increase productivity of existing, as well as new, areas;
- to increase and stabilize the income of farmers; and
- to promote large-scale or commercial-scale vegetable production.

Therefore, both long- and short-term strategies have to be developed. The short-term strategy is to increase productivity of the existing areas through improvement of support services and group farming while the long-term strategy should be the development of large-scale or commercial-scale production, particularly for new areas and the development of an agrobased or processing industry in tandem with vegetable production (i.e. integrated).

These objectives and strategies need to be translated into programs which can be implemented.

Production and management system. The production unit has to be reoriented, both in terms of organization and management in the existing areas, while for new areas, new production and management systems will be encouraged to develop into full fledged business enterprises.

Zoning and crop specialization. Crop zoning may not be necessary in the case of vegetable production, except for highland areas. The level of management provided will determine crop success. However, crop specialization is needed in vegetable production for export and processing, in order to take advantage of government incentives, infrastructures and export channels.

Production-marketing integration. In view of the high perishability and marketing problems associated with vegetable production, production-marketing integration becomes a basic prerequisite for large scale vegetable production in the future. Accordingly, a holistic approach to production, harvesting, handling, wholesaling and retailing needs to be adopted.

Besides the improvement in marketing information, market intelligence, promotional drives for export markets and developing additional wholesale markets, government efforts should include the provision of a comprehensive range of production, processing and export incentives and facilitating the greater involvement of producers in the marketing of their produce.

Research and technology transfer. Research would be orientated towards providing appropriate packages of technological support up to postharvest handling and processing for the various production and management systems envisaged. Technologies developed would be geared towards cost effectiveness and appropriateness, that would increase productivity and returns to the producers and processors. Research should also emphasize on vegetable farming systems aimed at optimizing use of resources, and must be multidisciplinary in approach. The technology transfer and promotion could be done through joint adaptive research, farm trials, demonstration plots either in group farming or minestates or through consultancy services.

Research needs to be given high priority on the major constraints in vegetable production in order to obtain high quality, resistant materials and appropriate, efficient production technologies (especially for large-scale production and labor saving) and postharvest handling to increase productivity. Research is also needed to enable suitable temperate vegetable crops such as Irish potato, onion, shallot and garlic to be grown successfully and economically in Malaysia. Seed supply problems have to be given special attention, especially in terms of quantity and quality. Likewise for the marketing aspects of the produce.

Technical Assistance

With regard to technical assistance, Malaysia would like to receive assistance in the following areas:

- training in areas of crop mechanization, seed production, commercial cultivation, crop protection, plant breeding and postharvest handling and processing;
- exchange of germplasm; and
- funding for procurement of equipment for crop mechanization, seed processing and postharvest handling.

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8

Research on Vegetables in Malaysia

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Vegetable Industry

The vegetable industry in Malaysia is very much smaller compared to the rubber, oil palm, cocoa, tobacco, rice and fruit industries. The cultivated area per annum fluctuates between 7,000 and 12,000 ha (Table 1). Annual local production of vegetables is about 480,000 t, of which about 15% is exported to Singapore. Although Malaysia is self-sufficient in the supply of fresh vegetables, every year we still have to import vegetables worth about US$68.7 million. The imported vegetables are: Irish potato, onion, shallot, garlic, chili, cabbage, processed and frozen vegetables. This figure excludes the value for beans and mushrooms (Table 2). The demand for vegetables in the year 2000 is estimated to be around 800,000 t, of which between 25% and 30% will be for export.

The production of vegetables in Malaysia faces many problems and constraints. Some of these problems are:

- Lack of high-yielding, high-quality, adaptable, pest- and disease-resistant varieties;
- Low level of productivity, hence high cost of production;
- Serious pests and diseases;
- Inaccessible source of quality seeds;
- High postharvest loss;
- Marketing problems; and
- Lack of support and services.

All these problems have to be addressed accordingly in order to meet the future demand.

Vegetable Cultivation in Malaysia

There are at least 50 types of vegetables being consumed in Malaysia; several of which are not grown locally. The list of the 15 most commonly consumed vegetables is presented in Table 3. This list differs from that in Table 4 which indicates the cultivated area of the most commonly grown vegetables in the country. Vegetables like potato, onion and shallot are mainly imported to meet the domestic requirement. These vegetables are not grown locally because of limited land area with higher elevation suitable for their cultivation, lack of adaptability to local conditions and uneconomic production.

With regard to AVRDC's principal crops, only sweet potato, chili and tomato are widely grown in Malaysia, with acreage of 1,588 ha, 1,500 ha and 652 ha, respectively. Soybean and mungbean are not grown in Malaysia because of economic reasons. On the other hand, the cultivation of Chinese cabbage is slightly smaller (461 ha) than English cabbage (512 ha). Moreover, Malaysians prefer English cabbage because it is more readily marketable.

Vegetable Research Program

Research on vegetables is mainly carried out by scientists from the Malaysian Agricultural Research and Development Institute (MARDI). Other institutions like the University of Malaysia

Table 1. Area of crop production in Malaysia, 1980-85.

Crop	Year					
	1980	1981	1982	1983	1984	1985
	(ha)					
Rubber	2,004,670	2,006,070	2,005,840	1,971,260	1,978,680	1,959,000
Oil palm	1,023,304	1,117,900	1,182,800	1,253,000	1,349,300	1,464,900
Cocoa	123,800	158,800	193,500	215,100	242,000	258,000
Rice	735,215	767,640	758,400	769,750	769,750	775,220
Coconut	349,400	318,000	319,000	324,000	298,000	274,000
Pepper (spice)	12,720	13,405	12,800	11,360	10,500	10,100
Pineapple	12,180	11,600	10,610	11,050	10,620	10,250
Fruit	93,000	87,800	89,000	90,000	92,000	94,000
Tobacco	12,450	14,290	9,570	9,440	9,310	9,130
Vegetable	12,800	12,520	7,460	7,620	7,830	8,090

Source: GOA 1986a.

Table 2. Volume and value of vegetables imported by peninsular Malaysia, 1984-86.

Type of vegetable	Volume (t)			Value (US$)[2]		
	1984	1985	1986	1984	1985	1986
Onion/Shallot	92,500	88,900	89,100	22,901	20,344	20,801
Beans (dried)	54,100	42,600	107,400	19,618	12,433	14,695
Potato	45,000	45,200	46,000	8,931	7,710	8,092
Cabbage	33,500	32,500	21,100	4,885	4,084	3,053
Garlic	20,000	16,500	22,700	12,595	10,458	12,405
Mushrooms	730	1,300	997	8,397	9,962	10,687
Tomato	5,600	9,000	5,300	2,824	2,099	2,672
Chili	16,000	18,000	24,000	11,450	11,641	10,115

Source: GOA 1986b. [2]US$1.00 = M$2.62.

Table 3. Projected vegetable consumption in 1985 for peninsular Malaysia.

Rank	Vegetable	Consumption (kg)
1	Chinese mustard	50,971
2	Long bean	42,936
3	Cucumber	41,894
4	Chili	39,571
5	English cabbage	36,365
6	Irish potato	35,528
7	Bean sprout (mungbean)	32,979
8	Eggplant	31,816
9	Onion	27,545
10	Tomato	25,552
11	Spinach	23,611
12	Water convolvulus (kangkong)	22,502
13	Shallot	20,633
14	Sweet potato	20,520
15	French bean	16,944

Source: Hanada 1987.

Table 4. Cultivated area for vegetables in peninsular Malaysia, 1986.

Vegetable	Acreage (ha)
Long bean	1,640
Sweet potato	1,588
Chili	1,500
Cucumber	1,249
Chinese mustard	1,246
Cabbage	987
Okra	747
Tomato	652
Eggplant	569
Luffa	527
Ginger	496
Water convolvulus (kangkong)	447
Bitter gourd	376
Spinach	207

Source: MOA 1986.

(UM), the Agricultural University of Malaysia (UPM) and the National University of Malaysia (UKM) are carrying out research on a smaller scale. The Department of Agriculture (DOA) does not conduct vegetable research; it is responsible for technology transfer and extension.

MARDI also conducts on-farm research with growers on technology verification, testing acceptability and appropriateness of the technologies, even though it is not responsible for extension work. The research programs of MARDI are formulated based on the above-mentioned constraints of the vegetable industry and the goals of the National Agriculture Policy (NAP). The NAP stresses that vegetable production should be upgraded to meet the increasing local demand and the export market through increased productivity of existing cultivated areas and the newly opened land.

The objective of vegetable research in MARDI is to develop appropriate and efficient production management practices and postharvest handling and processing technologies, to increase productivity in order to meet domestic requirement and to reduce imports, increase export earning and income of producers as well as diversify the utilization of products and by-products. Some of the specific objectives are:

- To develop superior, pest- and disease-resistant planting materials which are adaptable to the various types of environments in addition to providing high yield and good quality crops;
- To develop efficient production techniques and management systems to obtain high productivity and quality and prevent crop losses due to pests and diseases;
- To develop efficient postharvest handling and processing technologies to ensure high quality and high returns to producers; and
- To evolve, document and disseminate technical information and findings to growers/producers.

The above objectives will be met through identification of desirable varieties that are adapted to the local environment, identification of appropriate technologies to increase production, development of efficient management in production and postharvest handling and the dissemination of relevant information to clienteles.

These objectives will be achieved through six main research programs, namely:

- Development of improved planting materials;
- Development of efficient production systems;
- Management of pests and diseases;

- Technology promotion and transfer;
- Postharvest handling and processing; and
- Industry monitoring.

There are five research divisions in MARDI which are directly involved in vegetable research, namely: the Miscellaneous Crops Research Division, the Food Technology Division, the Techno-Economic and Social Division, the Central Laboratory Research Division and the Technology Promotion Division. Each division develops its own research projects and sets targets to achieve. However, the approach on vegetable research is multidisciplinary; this is to ensure that a complete technology package is developed. Research projects are normally planned for a period of five years, based on specific technologies to be produced. The targets are set up each year and attempts are made to achieve these through the implementation of proposed projects.

There is relatively less research in other institutions compared to MARDI. Their projects depend on the availability of research grants. For example, only seven officers from UPM are currently involved in vegetable research, mainly in breeding and selection of long bean, chili and sweet corn; physiology and nutrition of vegetables, especially on cabbage; and plant protection from viruses, especially on chili.

Lecturers from UKM also carry out research on vegetables, such as germplasm collection and evaluation of *Dioscorea* L., utilization of vegetable products, control of chili diseases and some basic studies, such as genetic and tissue culture. Lecturers from the UM, on the other hand, are involved in vegetable cultivation techniques for tin tailing soil (sandy) and hybridization of chili. Research carried out by these organizations is quite independent from that conducted by MARDI. Collaboraion on certain projects, however, exists between MARDI and the universities.

Vegetable research in MARDI is very important compared to crops like maize, groundnut, soybean and other field crops, and it is of equal status with research on cocoa, rice, fruit and tobacco. The fact that vegetables are considered an important crop means that research is carried out in more disciplines compared to the less important crops.

Research Collaboration

Vegetable research in MARDI has been given high priority since 1984. A multidisciplinary approach has been employed, where research activities in its five divisions complement each other. Collaboration is not only limited within MARDI, but also with other national and international organizations. Official collaboration exists between MARDI and the Asian Vegetable Research and Development Center (AVRDC), and the Tropical Agricultural Research Center (TARC) and the Vegetable and Ornamental Crops Research Station (VOCRS) in Japan at the international levels and with UKM and UPM at the national levels. Unofficial collaboration exists with seed companies in Taiwan, the Netherlands, the USA and Japan, and universities in these countries and others.

The areas of collaboration include introduction and evaluation of planting materials (with AVRDC and seed companies), collection of germplasm, evaluation and hybridization for specific traits (with AVRDC, TARC, VOCRS and private companies) and development of control measures in crop protection, such as control of diamondback moth (*Plutella xylostella* L.) on cabbage (with AVRDC). Locally, collaboration with universities is in the exchange of seeds, identification of pests or diseases and sharing of research facilities and information.

With reference to the bilateral program between MARDI (Malaysia) and AVRDC, although the two-year official collaboration concluded in July 1986, cooperation between the two institutions continues. The main objective of the collaboration was to strengthen vegetable research in Malaysia (in particular MARDI). In the past the main components of the bilateral program were conducting vegetable research, appointment of the resident scientists for Malaysia, introduction of planting materials, procurement of equipment and research facilities and training of scientists.

Some of the achievements of the program are shown in Table 5. Many scientists from MARDI were given various types of training while several AVRDC scientists visited Malaysia and advised Malaysian scientists on vegetable research and development. Several scientists from other institutions were also trained by AVRDC.

In the area of research, achievements were in the identification of promising lines of crops for Malaysia. These promising lines need further evaluation before making any recommendations concerning release. For example, tomato varieties, MT1 and MT11, were identified as the most promising and soybean varieties AGS 58, 1298, 130 and 154 were also identified as promising. Further evaluation of the selected materials is being carried out by MARDI scientists.

The other benefits gained from this collaboration were: training of MARDI scientists, introduction of planting materials, establishment of a linkage with the seed companies in Taiwan and sharing common problems with other countries in the network.

The weak points of the bilateral program were: no proper project was planned and implemented jointly, such as on the production of seeds (both open-pollinated and hybrid seeds), control of *Plutella xylostella*, identification and control of virus diseases and postharvest handling. Breeding of tomato is done in Malaysia, AVRDC and in other countries, but no attempt was made to coordinate these efforts. If such projects were coordinated, more results would have been produced. Collaboration should be on a specific project basis rather than on a general one. This will enable the resources to be used efficiently and to reduce duplication of research.

Another weakness in the Memorandum of Understanding was that there was no clear Terms of Reference for the Resident Scientist. At the beginning of the project this created confusion about the role of the Resident Scientist and his counterparts in the host country.

Research collaboration is very much needed in Malaysia for crop improvement (breeding for quality and resistant plant materials to serious pests and diseases), control of pests and diseases (particularly *Plutella xylostella* on cabbage, bacterial wilt on tomato and chili, and virus on chili and tomato), quality seed production (seeds of chili, tomato and cabbage) and postharvest handling of vegetables (postharvest loss, storage and quality control).

Research Constraints

Research in MARDI is fully funded by the government whereas research in the universities is funded mainly from research grants. Thus, government agencies like MARDI have fewer financial difficulties to carry out research than the universities. There are about 50 scientists directly and indirectly involved in vegetable research in MARDI, whereas only 13 scientists from the universities are conducting research on vegetables, mostly on a part-time basis. The research areas may not directly be in line with the NAP. The availability of funds determines the extent of the research undertaken. However, many types of vegetable and extensive research areas covered by MARDI resulted in insufficient funds being allocated for specific projects. Each year, about US$76,336 is allocated for vegetable research. The amount of money for vegetable research in the universities is very much smaller.

Manpower and research facilities are generally sufficient in Malaysia. However, scientists lack experience, especially in the area of integrated pest management, postharvest handling, seed production and crop improvement. The available manpower needs training to improve their research capabilities. A seed genebank is still lacking and is in the process of being established.

Research is also confronted with biological factors. Most of the vegetable cultivars or varieties imported into Malaysia do not grow well. More adaptable varieties of onion, shallot, garlic and potato are needed. Heat-tolerant varieties adaptable to short daylength, heavy rainfall and high humidity are required.

Another problem is the difficulty to secure inbred or pure lines for breeding and seed production purposes. Moreover, disease resistance in many imported varieties breaks down when tested locally, which is due to lack of expertise to do the job, insufficient genetic information and lack of cooperation between the countries involved. Seed quality is another problem related to this situation.

Table 5. Progress of the MARDI-AVRDC bilateral program on vegetable research in Malaysia, 1984-86.

Activity	Scientist involved	Date
1. Resident scientists (2)	Dr. C.C. Chu	Oct. - Dec. 1984
	Dr. El Mostafa Saadaoui	Feb. 1985 - June 1986
2. Visiting scientists (6)	Dr. N.S. Talekar, Entomologist	Aug. 1985
	Dr. Y.J. Young, Breeder	Sept. 1985
	Dr. B.A. Kratky, Crop Management Specialist	Oct. - Nov. 1985
	Dr. S. Lin, Breeder	
	Dr. R. Opeña, Breeder	
	Dr. S. Green, Virologist	
3. Training, (fellowship, study tour, research) (31)	Dr. Saharan Hj. Anang	Sept. - Oct. 1984
	Dr. Ali Hj. Hamid	Feb. 1984
	Mr. Abd. Rahman Daud	Feb. 1984
	Mr. Mohd. Shukor Nordin	Feb. - Jul. 1984
	Mr. Lim Heng Jong	Nov. 1985
	Mr. Abd. Rahman Haron	Nov. 1985
	Mrs. Melor Rejab	Feb. - March 1985
	Mrs. Mah Shook Ying	Feb. – March 1985
	Mr. Engku Ismail Engku Ahmad	Feb. - March 1985
	Dr. Ho Ban Lee	Feb. 1985
	Dr. Syed Abd. Rahman	Feb. - March 1985
	Mr. Leong Ah Chye	Oct. - Nov. 1985
	Mr. Khelikuzzaman M. Hussein	Oct. - Nov. 1985
	Mr. Yong Nam Hin	Feb. - June 1985
	Mr. Mohd Khairol Anuar	Feb. - June 1985
	Mrs. Siti Asmah Dzayauddin	July 1985 - Feb. 1986
	Mr. Ramli Omar	Sept. 1985 - Jan. 1986
	Mr. Azizan Ahmad	Sept. 1985 - Jan. 1986
	Mr. Abd. Rashid Endut	Sept. 1985 - Jan. 1986
	Mr. Zainol Abdul Aziz	27 Oct. - 21 Nov. 1986
	Mrs. Norlia Ahmad	27 Oct. - 21 Nov. 1986
	Mr. Albahari Sulong	Feb. - June 1986
	Mr. Mooi Kok Chee	23 Mar. - 22 Apr. 1986
	Ms. Fauziah Hj. Ismail	Feb. - March 1985
	Dr. Lee Boon Siew	22 Sept. - 7 Oct. 1986
	Dr. Abd. Razak Shaari	22 Sept. - 7 Oct. 1986
	Mr. Abd. Aziz Atta Mohammad	Feb. - March 1985
	Mr. Tengku Ariff Tengku Ahmad	4 May - 16 May 1986
	Dr. Ramli Mohd. Nor	22 Sept. - 7 Oct. 1986
	Dr. Ahmad Aman	22 Sept. - 7 Oct. 1986
	Mr. Azizan Shahid	Feb. - June 1986
4. Procurement of facilities and supplies	Car for resident scientists	
	Vegetable transplanters	
	Water pumps	
	Power tillers	
	Vegetable seeds	
5. Research		
Evaluation of cultivars and lines	Promising lines identified in soybean (4 lines), mungbean (2 lines), and tomato (5 lines)	

Table 5. Continued

Activity	Scientist involved	Date
Screening for virus resistance on chili	No promising line found	
Screening of tomato lines against leaf mould disease (observation)	No resistant line found	

Pests and diseases are also contributing problems to research or experimental crops. Many experiments failed to produce results due to crops damaged by pests and diseases. For example, the evaluation of cabbage varieties damaged by *Plutella xylostella* (L.) and *Hellula undalis* (F.); chili damaged by viruses, bacterial wilt and anthracnose; and tomato by *Heliothis*, virus and bacterial wilt, etc.

Due to greater public awareness of the health hazards of pesticides and the recent fear of chemical residue, greater emphasis should be placed on integrated pest management and resistance breeding. However, the lack of information and expertise on integrated pest management techniques and the length of time required for resistance breeding can be a constraint to research. For instance, the virus disease of chili is so prevalent and difficult to control that experiment results can be affected by serious infection.

Lack of certain technologies have also created problems for effective research. For example, in the study of cropping systems, poor crop performance often occurred due to the lack of information of the crop compatibility growing in the system. The research constraints and their probable solutions are shown in Table 6.

Table 6. Research constraints in Malaysia and their probable solutions.

Factor	Constraints	Solution
	Abiotic	
Funds	Minor problems	ADB assistance
Facilities	Lack some equipment for postharvest handling and seed production	Procure equipment
Manpower	Lack expertise and experience	Provide more staff training
Technology	Lack of information	AVRDC assistance
	Biotic	
Cultivar	Lack of adaptability and suitability	Introduce and/or develop more materials
Seed	Depend heavily on import, not assured quality	Produce locally, AVRDC assistance, import inbred lines
Pests and diseases	Damage in the field, lack effective control measures	Apply effective control measures, AVRDC assistance
Environment	Excess or insufficient water availability, soil infertility	Acquire and apply right technologies, IIMI and AVRDC assistance

Role of AVRDC

The research emphasis in MARDI and, in general, Malaysia is on crop improvement, development of technologies for cost-efficient production, effective pest and disease control, quality produce for consumers and sufficient vegetable supply for the country. MARDI and AVRDC have conducted considerable research to improve vegetable production, but there still

remains much to be done. Vegetable varieties planted are of poor quality and not resistant to pests and diseases. Cost of production is very high due to heavy investment in fertilizer, pesticide and irrigation. Loss of yield due to pests and diseases and damage at postharvest are substantial. Further studies in this field are required. In addition, Malaysia is importing annually about US$68.7 million worth of vegetables, such as onion, shallot, garlic, potato, chili, cabbage and otners.

Meanwhile, vegetable cultivation in Malaysia depends largely on seeds imported from Thailand, mainland China, Taiwan and other countries. The imported vegetables are very expensive and sometimes they are not always available in the market and/or are of poor quality.

Looking at the above-mentioned problems, support from AVRDC is needed in plant breeding, crop production techniques, pest and disease control, postharvest handling techniques and seed production. These can be realized through joint research projects and training of Malaysian scientists at AVRDC or in other institutions recommended by AVRDC.

In other words we hope AVRDC can play the following role:

- Collection, evaluation and maintenance of germplasm materials and development of new improved varieties adaptable to the region;
- Coordination in the collection of improved varieties and exchange of germplasm materials between countries involved;
- Repository of information on all important vegetables in the humid tropics;
- Provide expertise on technical aspects; and
- Continue providing training for scientists in the region.

As far as the crops are concerned, chili, tomato, cabbage, shallot/onion, asparagus and potato are given the highest priority. Extensive research is ongoing on these crops in various disciplines from breeding to postharvest handling, processing and economics. The focus in each discipline varies between crops, depending on the problems encountered.

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Discussion: Current Status — Malaysia

N. Amerasinghe: What is the role of the private sector in vegetable research?
Hashim B.A. Wahab: There is a very insignificant contribution by the private sector.

Paransih Isbagio: In your program you have a 'Production-Marketing Integration' program but in Table 10 on the man power distribution in vegetable research in MARDI, there is no scientist working on economics. How do you implement your program; by recruiting an economist from the universities or having collaboration with universities or by other means? To strengthen the collaboration of IARC's and NARS it is better to follow up the MOU by having an administrative arrangement on a project by project basis.
Saharan H. Anang: Actually, there is an economist who is working on a part-time basis in the economics of vegetables.

N.S. Talekar: In what way can AVRDC help Malaysia in pest control?
Saharan H. Anang: AVRDC can become involved in planning and implementation of projects such as on the IPM of *Plutella* and virus control on chili.

A. Makmur: What is the Malaysian experience in research collaboration between MARDI and university research? For example in taking advantage of graduate students' research in solving man power problems in research.
Saharan H. Anang: We have very close collaboration between MARDI and the universities such as in the exchange of materials and others. Universities utilize students to carry out research but not in the same manner as in the USA.

T.C. Yap: I would like to say that the relationship between universities and MARDI or other research organizations is very good. We normally exchange the breeding materials freely. The researchers from research organizations also enroll in the universities for further training. Hence, in my opinion, some research grants can be channeled to universities for specific problem solving in which case the grant can be effectively used. In fact in the U.S.A. a lot of problem-solving projects have been successfully conducted by postgraduate students. Perhaps AVRDC is able to give a portion of the grant in this form.

R.L. Villareal: (1) What are the crops included under MARDI's Crops Research Division? (2) How much is the budget of your division? (3) What is the share of vegetable crops in that budget?
Saharan H. Anang: (1) The crops under the Miscellaneous Research Division include vegetables, flowers, spices, beverages, field crops and other minor crops. (2) The budget allocated for vegetables is about US$200,000 a year. (3) The total budget for the Division, excluding development, is about US$1.3 million a year.

M.R. Hernais: Crop zonification and specialization is one strategy identified in your vegetable implementation program. Can you amplify on this in terms of identifying the attendant factors or parameters that you consider in identifying specific areas for the planting of specific crops?
Hashim B.A. Wahab: Specialization is determined on the basis of purpose of vegetables: processing types in certain areas, e.g. tomatoes, and vegetables eaten fresh are confined to other areas.

M. Kamiya: (1) Malaysia exports the highest percentage of total production of vegetables among Asian countries. It is said that this is due to a traditional relationship with Singapore. What is a traditional relationship? (2) Some items of vegetables are listed both in import and export items. What is the reason?
Hashim B.A. Wahab: (1) Malaysia has had very strong ties with Singapore for a long time. Malaysian products are reexported through the Singapore market. (2) This is due to the

difference in growing season -- Malaysia imports some vegetables during some seasons and others are exported.

Subijanto: We need information on the following successful projects of Malaysia: (1) solution to excessive pesticide use in the Cameron Highlands; (2) promotion of large-scale vegetable production; (3) conditions implemented in cooperation with seed companies; and (4) proposal for AVRDC/Malaysia Phase II Project.

Saharan H. Anang and Hashim B.A. Wahab: (1) Steps taken to counter the problem include intensifying extension services on pesticide use to farmers in the Cameron Highlands, organize dialog/seminar with vegetable growers, requiring farmers to label their product for export (for identification of exporters), and continued sample analysis to detect pesticide levels on vegetables. Exporters with produce exceeding allowable levels will be fined and banned from exporting in the future. (2) Farmers are encouraged to improve their production through utilization of improved technologies, both in existing as well as newly opened up areas. Support services are provided by government agencies like the Dept. of Agriculture, MARDI and FAMA in the form of technologies, some inputs and infrastructures, market information and other incentives. Group farming is encouraged or organized for small growers. (3) No condition was put yet to seed companies for testing or selling their products in Malaysia. However, we are concerned with the seed purity, true to types and percentage of viability. For research testing we normally request varieties that are suitable to our environmental conditions like short daylength, high rainfall/humidity and which possess certain quality and resistance. (4) We plan to continue introducing and evaluating materials developed by AVRDC and from other sources; sending scientists and technicians to AVRDC for training in specific areas for upgrading skill and expertise; to implement research and development on crop improvement, control of major pests and diseases, seed production and postharvest handling.

C.L. Luh: I suggest AVRDC becomes a trouble shooting agency instead of a catalytic agent. Malaysia's vegetable shipment was rejected by the Singapore government due to chemical residue. This is a good example for AVRDC scientists to find out the causes, and how to prevent it from happening again for the benefit of consumers in the region. This is an important issue meriting deep investigation and would provide information for other countries.

G.A. Marlowe: AVRDC would very much like to assist NARS in their diagnostic needs; but due to continuing budgetary constraints travel costs for our scientists must often be limited to multipurpose trips or from external funding support.

Forty Years of Vegetable Research and Development in Taiwan

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Background

It was recognized in the early 1940s that the nutritional level of people in Asian countries was inadequate for a number of reasons. People in Taiwan were especially in great need immediately after World War II for clothing, housing, transportation, education and food supplies. The diet consisted mainly of starchy food, notably rice, sweet potatoes and cassava. These food crops kept the population alive but they did not contain nearly enough proteins, vitamins and minerals. Although there was not enough vegetable production, concerned government agencies paid little attention to vegetable research because there were more pressing problems. Vegetable research and production received a very low priority in terms of financial support and project implementation compared to rice research and production. This situation was clearly observed and understood in those years.

The Initiation of Vegetable Activity

A vegetable survey, financially supported by the Sino-American Joint Commission on Rural Reconstruction (JCRR), was conducted by the Taiwan Agricultural Research Institute (TARI) in 1952. As a result of this survey, first-hand information on vegetable production, its constraints and possible solutions was obtained. Based on this survey, a series of projects for vegetable research was initiated by JCRR, in cooperation with different agricultural research and improvement stations of the Provincial Department of Agriculture and Forestry (PDAF). JCRR provided financial and technical support to these projects. This continuous implementation of vegetable research programs and constant attention to vegetable production and marketing is considered today as the principal reason for a healthy system of vegetable research and production in Taiwan.

Research on Cultural Practices and Varietal Improvement

Onion

A number of examples can be reported with regard to vegetable improvement through the research effort. For example, both onion (*Allium cepa* L.) bulbs and white potatoes were imported commodities which fetched a very high price on the local market. These two vegetables were considered delicacies in Taiwan. Vegetable research workers set out to determine why we did not grow our own onion and white potatoes. After repeated failure among the varieties tested, Texas Early Grano 502, an early US commercial onion variety, showed promising results for maturity, quality and yield. After identification of this variety, an extensive trial planting, demonstration and regional testing in both the stations' and farmers' fields followed. Finally, onion growers were asked to contract with Farmers' Associations in order to control the acreage

and yield for export as well as domestic consumption. This formerly imported vegetable crop became an export commodity within the 10-year research and development program of continuous planning, implementation and supervision. Inexpensive fresh onions are now available almost year-round in Taiwan.

Potatoes

White potato (*Solanum tuberosum* L.) or Irish potato had a similar initial situation as onion but it took a much longer period of time to resolve the problems. Research workers at TARI started the production of seed potatoes at high altitude in order to eliminate the aphids which caused virus diseases. Success was initially limited in raising potato seed in mountain areas during the summer season and growing potato crops in the lowlands of central Taiwan during the winter months. Even before the development of tissue culture techniques in Taiwan, the importation of white potatoes finally ceased and was substituted with the export of a small amount of white potatoes to Hong Kong and Singapore. With the introduction of tissue culture, healthy potato seeds became a dependable part of commercial production in the early 1970s. One hectare of land had an average yield of 30 t of potatoes.

Introduction of New Crops to the Subtropics

Mushrooms

Thirty-five years ago the mushroom (*Agaricus bisporus* Sing) was recognized worldwide as one of the most expensive vegetables and only the wealthiest were able to afford this delicacy. It was also thought that only crazy people would dream to grow mushrooms under the subtropical conditions of Taiwan. Nevertheless, mushrooms grew well through a team approach; first in 1951 at an abandoned gold mine in northeast Taiwan with spawn from Pennsylvania, USA. Research workers at TARI and specialists at JCRR were stimulated as well as puzzled by these results. It was not easy to find solutions to the many problems which confronted them.

Approach. Research workers finally focused their attention on the environmental conditions and replacement of the horse-manure medium for an adequate growing medium. Creating an environment desirable for mushroom cultivation in the 1950s was not an easy job. Measurements which included temperature, humidity, ventilation and others were made in the abandoned mine during the trial planting which was conducted in a soap box. A wide temperature range from 18° to 30°C was kept for reference.

Solution: synthetic compost. Horse manure is the normal medium for mushroom growing in most mushroom-producing countries. However, horse manure is scarce in Taiwan due to the limited number of horses. The lack of horse manure limited the chances for successful commercial cultivation of mushrooms in Taiwan. Fortunately, a joint effort of research workers from different institutes finally developed a specially formulated synthetic compost for mushroom growth. This synthetic compost is much more sanitary than the animal manure.

As soon as the growing condition and cultural medium produced effective results, commercial mushroom production by individual growers became possible and efficient. The attractive price of mushroom offered in the world market also stimulated the industry to grow. The research on mushroom biotechnology in the early 1950s in Taiwan changed traditional mushroom growing into a more technologically developed industry.

Organized team approach. The research workers interested in the mushroom projects covered a wide range of disciplines. They were divided into four groups: i.e. spawn making and varietal improvement; compost making; mushroom house improvement; and plant protection.

The number of research workers varied from only four to five in the early 1950s and gradually increased up to around 200 in 1980. Public funds were not allocated to mushroom research; all funds came from the industry through organized channels. The Taiwan Canners Association generated research funds from every case of exported mushroom. These funds were spent for projects approved by the Taiwan Mushroom Research Committee, Ministry of Economic Affairs (MOEA). I was the convener of the said committee from 1962-71.

Asparagus

The first trial planting of asparagus (*Asparagus officinalis* L.) at the District Agricultural Improvement Stations was conducted in the 1960s. This initial trial was conducted to determine the possibility of growing this temperate crop under the subtropical conditions of Taiwan. Should this attempt prove workable, then people in Taiwan would be able to enjoy this vegetable without spending foreign exchange.

Adjustment of cultural practices. After repeated study and observation in the field, research workers found that the growing of asparagus in Taiwan became feasible only after some adjustment in the method of cultivation. Normally, asparagus requires two full years of growing in the field before a harvest can be obtained. The top of the plant was customarily removed after one growing season in order to store enough food in the crown for the new growth the next year. However, due to the warm climate in Taiwan, asparagus kept growing and a sizable spear could be harvested within one year. Repeated studies were carried out whether the mother-stalk method or partial mother-stalk was the most appropriate.

Project funding. Asparagus research funds were obtained partly from the industry and partly from the government. In 1970 an asparagus research station was established in south Taiwan under the Tainan District Agricultural Improvement Station (DAIS). Projects of a long-term nature are conducted there and have generated a number of further improvements.

Improvement of Seed Production

Vegetable growers in postwar Taiwan suffered greatly from a supply shortage of vegetable seeds for their planting. If vegetable seeds happened to be available on the local market, they were poor in quality, germination, low in purity and not fresh. The United Nations once provided a relief supply of vegetable seeds of various crops, among which were okra (*Hibiscus esculentus* (L.) Moench) and hyacinth bean *Dolichos lablab* L. (*Lablab vulgaris* Savi). When these seeds were distributed to local growers, they were astonished at their poor quality and these seeds remained unutilized because they were new to the growers.

With the cooperation of three Far East Seed Improvement Workshops held in Taipei (1959), Manila (1961) and Tokyo (1963), farmers in Taiwan recognized the importance of seed to crop production. Growers were informed of the value of good seed and the proper way of harvesting, processing and handling. Several agricultural improvement stations and agricultural research institutes were engaged to improve methods of seed production for vegetables such as radish (*Raphanus sativus* L.), Chinese heading cabbage (*Brassica pekinensis* (Lour.) Rupr.), cauliflower (*Brassica oleracea* var. *botrytis* L.), cabbage (*Brassica oleracea* var. *capitata* L.) and kohlrabi (*Brassica oleracea* L. var. *caulorapa* DC.).

In the early 1960s the Taiwan Seed Service of PDAF installed the first cold storage facility for storing vegetable seed in Taiwan with financial support from JCRR. A number of curing sheds were constructed at different agricultural stations in order to insure that quality seed could be maintained before processing. Seed cleaners were imported from the USA in order that the vegetable seeds produced in agricultural stations could be properly processed according to specification. In the meantime a number of seminars and short courses on seed technology were conducted with lecturers invited from American universities.

As previously indicated there was a serious shortage of vegetable seeds in Taiwan and the seeds available on the local market were not of good quality and poorly packed. Indicative of the situation were the complaints of farmers on Kinmen Island who found radish seeds mixed with Chinese cabbage seeds in the seed shipments from Taiwan in the early 1950s. However, in a joint effort which focused on seed improvement, research workers and a few outstanding seed farmers, improvements developed in the production, curing, processing, packaging and storage of a limited number of vegetable seeds.

The seed quality of cauliflower had been greatly improved, i.e. high purity, germination rate and true to type. Due to limited supply, these high-quality cauliflower seeds commanded a high price on the local market. After a year or two, imported cauliflower seeds from Japan appeared on the local market and claimed an even higher price than the local variety. However, it was disclosed that these so-called Japanese cauliflower seeds with a Japanese seed company label were produced in Taiwan, shipped to Japan, repacked and then imported back into Taiwan. People in Taiwan had a deep-rooted belief that Japan had the best quality seeds!

Seeds for Peace

In the early 1970s Taiwan was asked by the Philippines to supply a large quantity of vegetable seeds. It air-shipped 5 t of various kinds of vegetable seeds as a gift to the Philippines; unfortunately this "seeds for peace" program did not evolve into a continuing basis.

Manpower Development

The number of vegetable research workers in the postwar years was unusually meager. In those years agricultural activities in Taiwan were centered on rice and sugarcane production by the government. Sufficient supply of rice, the staple food, was the first priority while sugarcane production was the main source of foreign exchange which was desperately needed. Therefore, the majority of research workers in agricultural research institutes or stations was engaged in rice research: only one or two people in a station were able to study crops other than rice. Throughout the island, there were no more than a half dozen research workers with BS degrees engaged in vegetable crops. Most of the researchers were agricultural vocational senior high school graduates; but they were hard workers with considerable experience.

Through a USAID program, a number of vegetable research workers were able to receive technical training for a period of six months to one year in certain American universities. Most of them received on the job, classroom and laboratory training. This technical training abroad was recognized to be very helpful in upgrading our limited vegetable research experience.

When scholarships became available for advanced study abroad for different branches of science, some college graduates interested in advanced study took vegetable crops as a major course of study. They went to Australia, the USA, Japan and European countries such as the Federal Republic of Germany; most of them returned to their original positions devoted to vegetable research and development.

The number of civil servants in government stations was limited. Since it became impossible to increase their number for vegetable research, either in agricultural stations or in the college of agriculture of any university, as the number of vegetable crop research projects increased the manpower shortage was eventually solved by employing college graduates as project employees for a period varying from one to three years, depending upon the nature of the project.

The utilization of college graduates as project employees paved the way for providing additional research manpower in a very economic and efficient manner. It not only provided young college graduates with job opportunities but at the same time supplemented the manpower needed for vegetable research.

These project employees working under the supervision of either research workers in an agricultural research station or under the direction of a professor in the college of agriculture

were able to deal directly with the problem under study. They had direct contact in the front line and understood where the problem existed and the reasons why it happened. They helped to understand a problem by the generation of a large amount of raw data for analysis. The performance of the project employee system was well recognized and this system is still employed in some research projects today.

In addition to receiving technical training and advanced studies abroad, the limited number of vegetable research workers at both the university and agricultural research stations were asked to participate in one- to three-day short training courses. These short courses utilized a foreign visitor or a colleague freshly returned from abroad in order to obtain new technology and information. This kind of seminar and short-course training was also found to be very helpful and educational.

Transfer of Research Findings to Farmers

The transfer of technology from the research institute to the farmer remains one of the major items for serious discussion in national and international agricultural research. AVRDC may also be accused of being unable to transfer its research findings effectively to its member country farmers. Frankly speaking there are no easy solutions. It is a problem and an issue which requires lengthy discussion in order to develop a workable solution.

Division of Responsibilities

When we think about transfer of research findings, one immediately refers to "extension". Extension has been generally employed for several generations by agricultural workers for the promotion of certain new technology to farmers. In Taiwan the division of research, testing and extension activities is as follows: the Taiwan Agricultural Research Institute (TARI) is assigned to do research only; all the District Agricultural Improvement Stations (DAIS) are responsible for testing in their respective areas and Farmers' Associations, which are nongovernmental agencies, are asked to undertake the extension service for their member farmers.

Actually, the extension service was not and is still not adequately handled by the Farmers' Associations. There are several organizations engaged in extension activities, depending on the crop. For example, the Taiwan Sugar Corporation is responsible for extension service for its sugarcane planting, the Taiwan Monopoly Bureau is authorized for the extension of tobacco planting, the Taiwan Fruit Cooperatives are in charge of extension of banana and citrus fruit crop production; the Taiwan Tea Corporation is in charge of tea planting extension services, etc. The Taiwan Provincial Farmers' Association participates in the extension service for rice, corn, onion, asparagus, mushroom and white potato, but pays no attention or interest in other vegetable crops at all. The transfer of research findings to farmers in Taiwan is not very sound; there is room for improvement.

Extension in the Past

It was previously stated that the number of people engaged in vegetable crop research was very limited. This situation is, however, not entirely disadvantageous. Because of the limited number of people, communication among fellow workers in small groups was facilitated. Most of our transfer of research findings was effectively carried out by research workers in accordance with the following steps.

A trial planting of a new crop variety or a new cultural method was first made in the station's field for close observation. When a successful research station trial planting was recognized and accepted by workers, an observation plot in the farmer's field was established. Those particular farmers who showed an interest in the new variety or cultural method were asked to serve as larger-scale extension field workers and were provided with technical supervision

and a symbolic subsidy. They were asked to explain their experience in their own terminology to their friends and relatives. Next, field-day observations and half-day classroom lectures by research workers, not by extension specialists, were held for large groups of growers. These kinds of gatherings were usually assisted by local township offices and Farmers' Associations which notified interested farmers about these activities. There has not been enough manpower assigned specifically for vegetable extension activities. Specific programs for vegetable extension probably require more time to develop. We should not copy everything from the USA because we had different social and educational backgrounds. We must develop methods suitable to local conditions.

Problems with Improvisation in the Past

In the early stage of commercial onion production, short courses and field days were conducted in many towns and villages. Farmers who wished to grow onion automatically attended such gatherings. The lack of extension expertise was clearly visible in a 4-H club worker engaged in handling extension activities with young club members. He was very enthusiastic in telling how to grow onion with an extension pamphlet titled "Onion growing". He was very eloquent and talkative in introducing the procedures to grow onions based on the pamphlet page by page. Although he was well acquainted with the extension methods and techniques, he exhibited a lack of actual knowledge about the onion itself because he had no training in crop production. He was more or less like a phonographic machine and had no answer when a question was raised by his audience. He even was unable to distinguish onion from wheat seedling, which looks similar in appearance in certain respects. This happened in Taiwan in the 1960s.

It is essential that extension experts or specialists know their subjects well. Otherwise there is the danger that farmers will receive the wrong information.

Recent Vegetable Research and Development Constraints

Erosion from Summer Highland Production

The high temperatures and humid conditions of the tropical lowlands favor most plant development but not leafy vegetable crops production during the summer months. Therefore, mountain areas above 1,000 m altitude were developed for summer vegetable crop production.

Induced by good cole crop production due to the cool temperature and the attractive market price offered because of the limited supply during the hot summer months, considerable sloping land in the highlands was developed into vegetable fields, with or without soil-water conservation measures. Consequently, soil and water erosion became a serious problem. Landslides, damage to water reservoirs and highways, etc. greatly affect the security of the people living in the mountain areas, as well as those living down stream. Although research workers helped the growers to select the proper crop variety, time of planting and cultural techniques to make a profit, they have not been effective in preventing soil erosion as a result of summer vegetable crop production in the highlands. This problem requires immediate solution to arrest further erosion while continuing to supply fresh leafy vegetables for local market demand. This new problem needs to be resolved by the appropriate group of specialists because it is beyond the capability of vegetable research workers.

Establishment of Frozen Food Industry

It might be helpful to improve the supply of vegetables during the summer with frozen foods. The plentiful supply of fresh vegetables during the winter months causes a very low price for vegetable growers in the lowlands. If the healthy food processing industry could invest in a frozen vegetable industry in the near future, soil erosion in the highlands could be reduced

by reduction of highland plantings. The profit margin in summer highland vegetable production would be limited if an adequate supply of frozen vegetables, packed during the winter, became available for the summer market.

Chemical and Fertilizer Pollution

We are well aware of the serious pollution problem. The air is heavily polluted with industrial wastes and the soil and water are heavily polluted with agricultural wastes, chemicals and fertilizers. Fresh vegetable crops are also contaminated with pesticides, fungicides and their residues. Eutrophication has become a common phenomenon found in most water bodies in Taiwan. Studies indicate that these facts reflect the improper manner of fertilizer and pesticide application by farmers in general.

Because of the intensive crop rotation system developed in Taiwan, most lowland fields usually produce at least three crops from the same piece of land each year. Obviously, soil fertility is seriously affected. Farmers customarily apply about 20 t of organic manure per hectare of land in order to maintain soil fertility. Unfortunately, as the supply of organic manure became scarcer owing to farm mechanization, farmers, especially vegetable growers, had no alternative but to increase their chemical fertilizer application. Vegetable growers, as well as fruit growers, also inappropriately apply fungicides, insecticides and other agricultural chemicals. These chemicals provoke a poor soil texture, disturb the microecosystem of the soil and produce a serious and harmful chemical residue problem on both fruit and vegetable crops.

In spite of government regulations regarding the proper use of agricultural chemicals and fertilizers, growers who are self-centered on their crop production and profit, need further education in order to improve the current pollution problem.

Marketing: A Bottleneck to Profit

The reason farmers grow vegetables is to make a profit. The profit margin in growing vegetables is greatly influenced by a number of factors: i.e. the type of crop, the season, the weather, the cultural practices utilized, the water supply and drainage conditions, the quality of seeds, the season and location of the market, as well as postharvest handling and packaging and method of shipping, etc. However, profit is finally decided by the principle of supply and demand. Therefore, it would be rather difficult for an individual vegetable farmer to predict his own profit or loss owing to the many unknown factors he is faced with.

In the past, under favorable weather conditions and careful monitoring of the situation, vegetable growers could make a reasonable profit unless hit by typhoons or tidal waves. The average size of a vegetable farm is around 0.3 ha in Taiwan. With this limited land area and resources, it is very difficult for the vegetable grower to diversify into any other activity; he has to live with the existing conditions. Vegetable farmers work hard all year and receive an average of between 20% to 30% of the value of the market price of the crop marketed. The balance (70% to 80%) of the market price of their produce goes to the transporters and retailers. Most vegetable crops are marketed through local wholesale markets and are then shipped to urban consumer markets.

Due to the low value of agricultural commodities when compared to most industrial products, farmers' income is roughly only 70% of nonfarmers' income. When affected by natural disasters such as flooding, typhoon or earthquake, the price fluctuation of vegetable crops on the retail market always increases several fold, yet the vegetable growers at the center of production receive no additional profit. In these situations all price increases go to the retailer and middlemen. This situation presently creates a great disappointment of the vegetable growers toward the government's marketing system policy.

Although the greedy middlemen have a strong and tight organization among themselves, the vegetable farmers have no such organization. Consumers usually pay a very high price for produce but the farmers income can even drop from 20% to 30% average to less than 10%

of the consumer price. Vegetable growers market their produce through middlemen because they have the collection, shipping and marketing channels.

Farmers' Associations sometimes collect fees at the market operated by the producing township; but they are not responsible for handling the packing, shipping, etc. of the marketing business. This is a weak point of the Farmers' Associations. Unfortunately, the Farmers' Association is a farmers' organization which receives supervision from the local government. Therefore, farmers seriously complain about the marketing policy of the government. So far, agricultural economists in government organizations have not responded to farmers' complaints. This has led to farmers demonstrating in the cities of Taiwan in recent months.

Conclusion

The vegetable per capital consumption has tripled in 40 years. This increase was made possible through vegetable research, production promotion and farmers' hard work. It is a joint effort accomplished through a team effort under a balanced mix of scientist, farmers and trade components.

Now most agricultural experiment institutes or stations are much better equipped with hardware and software, and the well-trained scientists are more adequately funded than 40 years ago. But they are faced with more complex and sophisticated problems; some are biological in nature and others are social, economical, educational and even political in nature.

I believe that with more trained people and today's advanced technology and facilities, an effective and efficient method of vegetable research and development can be attained in the near future. In addition, a knowledgeable and reasonable research manager in all research activities becomes indispensable to a successful implementation of the research and development program.

Appendixes

Appendix I. Acreage, unit yield and production of major crops in Taiwan, 1986.

Crop	Acreage (ha)	Yield (kg/ha)	Total production (t)
Rice	531,561	4,697	2,496,510 (husked rice)
		3,863	1,973,823 (unpolished rice)
Vegetables	239,707	13,049	3,127,896
Fruit crops	175,154	12,684	1,837,734
Corn	76,762	3,628	271,660
Sugarcane	64,573	93,547	6,001,871
Peanuts	56,592	1,569	77,150
Tea	26,389	988	23,890
Sweet potatoes	22,062	15,386	324,042

Source: 1986. Taiwan Agricultural Yearbook. Provincial Department of Agriculture and Forestry (PDAF), Taiwan.

Appendix II. Distribution of full-time vegetable research workers by level of training, May 1988.

Institute engaged in vegetable research	PhD	MS	BS	2-3 yrs. college	Vocational agric.	Total
Taiwan Agricultural Research Institute	3	3	1	–	1	8
Fengshan Tropical Horticultural Expt. Sta.	1	3	2	–	1	7
Taoyuan District Agril. Imp. Sta.	–	3	1	2	2	8
Taichung District Agril. Imp. Sta.	1	3	–	1	–	5
Tainan District Agril. Imp. Sta.	–	3	2	–	1	6
Kaohsiung District Agril. Imp. Sta.	–	–	1	2	2	5
Taitung District Agril. Imp. Sta.	–	1	1	1	2	5
Hualien District Agril. Imp. Sta.	–	2	–	3	1	6
Taiwan Seed Service	1	2	3	–	2	8
Subtotal	6	20	11	9	12	58
Asian Veg. Res. and Dev. Center	18	10	13	13	17	71
Total	24	30	24	22	29	129

Source: Personal correspondence with officials of the Council of Agriculture, June 1988 and personal correspondence with officials of AVRDC, June 1988.

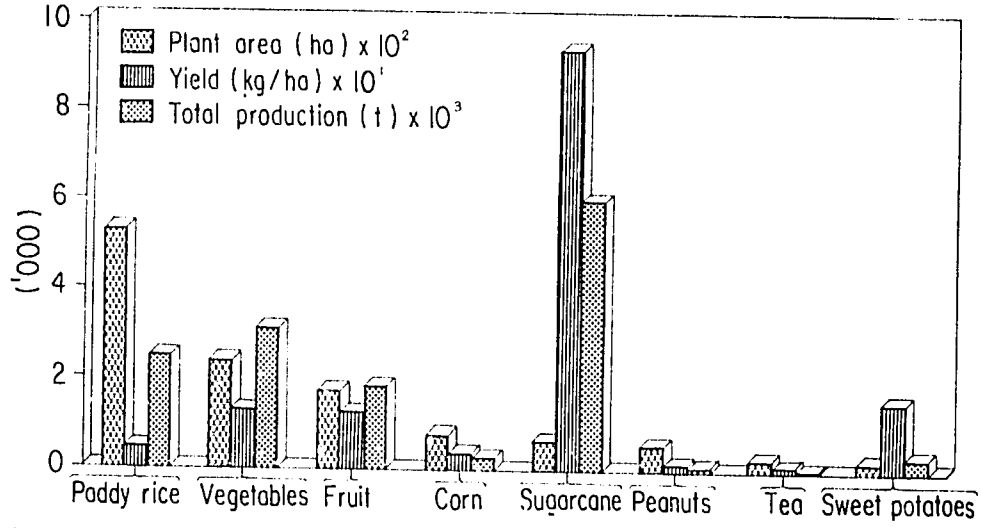
Appendix III. Production and consumption of vegetable crops from 1945-86.

Year	Planted area (ha)	Yield/ha (kg)	Production (t)	Population ('000 plants)	Consumption/year (kg)
1945	35,319	8,567	302,575	6,090	38
1951	78,601	7,834	615,789	7,869	63
1956	81,859	8,190	670,460	9,390	58
1961	90,556	8,991	814,482	11,149	57
1962	94,247	8,928	841,409	11,512	56
1963	101,685	8,956	910,695	11,884	60
1964	101,107	9,632	973,875	12,257	57
1965	108,808	8,898	968,159	12,628	57
1966	112,886	8,533	962,281	12,993	53
1967	114,754	9,166	1,051,820	13,297	53
1968	118,462	10,208	1,209,293	13,650	68
1969	133,594	10,968	1,465,291	14,335	75
1970	141,540	11,906	1,658,191	14,676	85
1971	146,706	12,032	1,765,096	14,995	91
1972	148,557	11,468	1,703,663	15,389	91
1973	154,798	12,152	1,881,062	15,565	93
1974	167,737	11,559	1,938,939	15,852	99
1975	187,381	11,881	2,226,308	16,150	110
1976	191,966	12,743	2,446,282	16,508	118
1977	201,886	12,815	2,587,243	16,813	112
1978	220,279	12,701	2,785,680	17,202	115
1979	226,899	13,245	2,993,870	17,479	118
1980	230,977	14,038	3,224,849	17,805	110
1981	221,407	13,186	2,910,853	18,136	116
1982	227,513	13,379	3,044,099	18,458	118
1983	224,614	13,439	3,018,741	18,733	117
1984	232,655	14,684	3,416,382	19,013	129
1985	226,443	14,323	3,243,364	19,258	127
1986	239,707	13,049	3,127,869	19,455	118

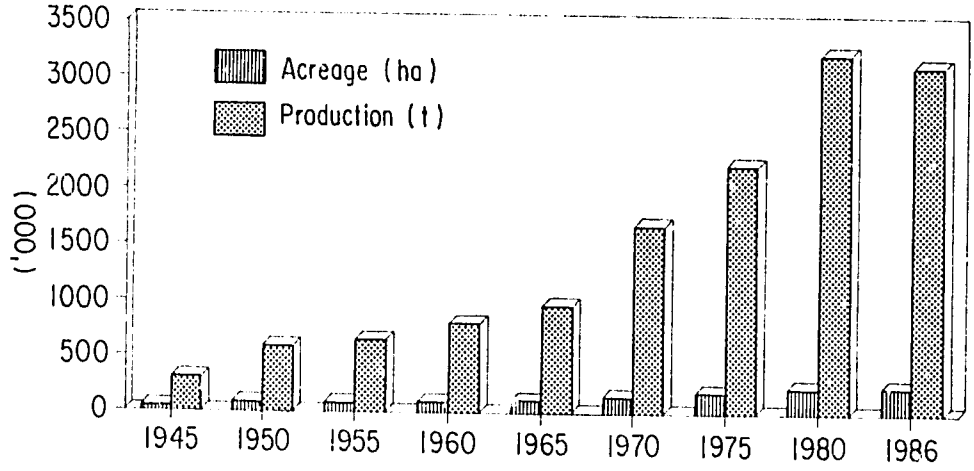
Source: 1986. Taiwan Agricultural Yearbook. Provincial Department of Agriculture and Forestry (PDAF), Taiwan.

Appendix IV. Number of papers on vegetable research and development published in Taiwan from 1945-88 (in Chinese).

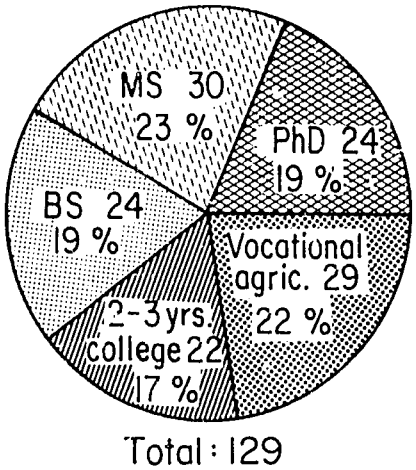
Period	No. of years	No. of papers published	Average no. of papers published/year
1945-1955	10	180	16
1956-1965	9	278	28
1966-1972	6	806	115
1973-1980	7	935	117
1981-1986	6	1850	308
1987-1988 (May)	1.5	402	402



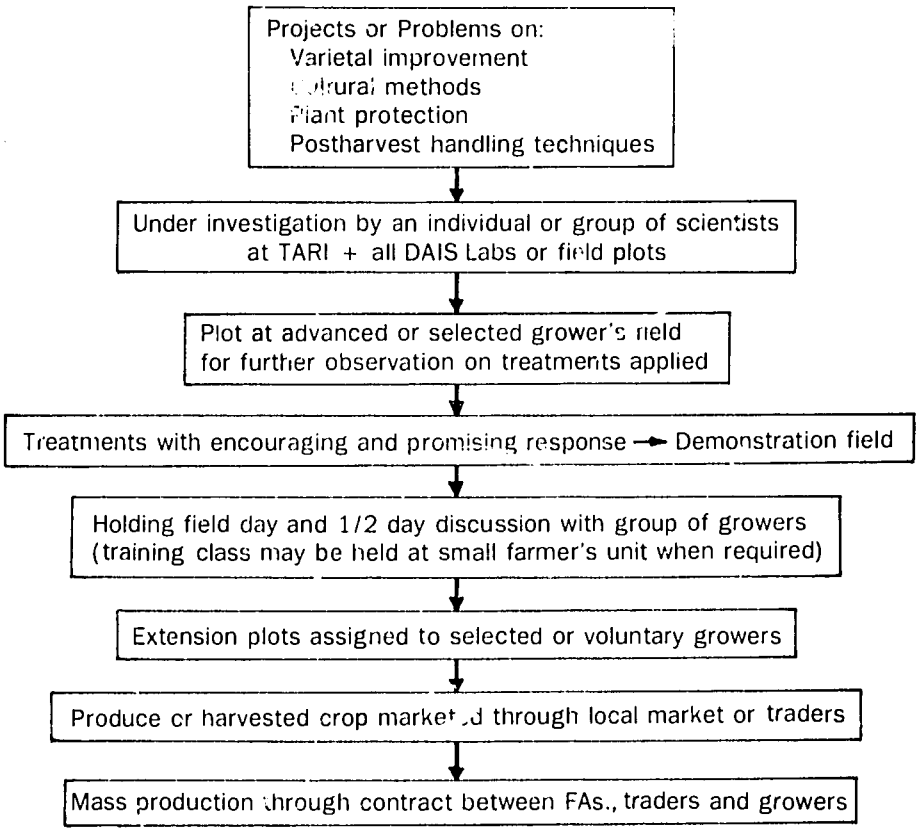
Appendix V. Acreage, unit yield and total production of eight major crops in Taiwan, 1986.
Source: 1986. Taiwan Agricultural Yearbook. Provincial Department of Agriculture and Forestry (PDAF), Taiwan.



Appendix VI. Review of Taiwan vegetable production, 1945-86.
Source: 1945-86. Taiwan Agricultural Yearbooks, Provincial Department of Agriculture and Forestry (PDAF), Taiwan.



Appendix VII.
Distribution of full-time vegetable research workers by level of training, May 1988.



Appendix VIII. Transfer of research findings, 1950-80.

Discussion: Current Status — Taiwan, China

M.R. Hernais: You mentioned in your paper that at a certain point in time vegetable farmers were only receiving 20% to 30% of the profit and the rest was going to the middle men. Does this situation still exist now? If not, what measures have been adopted to correct or remedy this practice?
C.L. Luh: This situation has not changed! I believe that eventually the agency concerned will look into this problem and seek an effective solution.

Hashim B.A. Wahab: Can you explain why industrial development has not adversely affected vegetable development (see Table 3 of your report). More farmers are involved in vegetable production.
C.L. Luh: Vegetable growers near big cities are specialized in vegetable growing, they will not go to the factory. Growers away from big cities are more or less engaged in full-time activities, they found it unwise to go to the factory too.

Paransih Isbagio: What is the mechanism of research-extension linkages in Taiwan? Are research findings from the Taiwan Agricultural Research Institute (TARI) directly transferred to the Farmers' Associations or from TARI must research findings be transferred through the District Agricultural Improvement Stations (DAIS) and then to the Farmers' Associations?
C.L. Luh: In most cases, TARI must transfer its findings through DAIS then to selective Farmers' Associations.

R.L. Villareal: Who are the primary contributors to the increase in publications on vegetable research and development in Taiwan?
C.L. Luh: Mostly from researchers of Agricultural Research Stations and also from university professors and DAIS members, as well as from Farmers' Associations.

N.S. Talekar: During the past 3-4 years, vegetable consumption has been going down. Do you think this trend will continue?
C.L. Luh: It is a matter of normal fluctuation. Fast-food in recent years may be one of the reasons causing the per capita consumption to go down. It probably will return to normal.

Subijanto: Would it be possible for AVRDC to arrange to translate publications in Chinese on vegetable research findings?
C.L. Luh: I do not think AVRDC has the possibility to translate publications in Chinese into English. But you may try to ask the Food and Fertilizer Technology Center (FFTC) in Taipei to consider the possibility. They used to cover vegetables in their program.

J.T. Sykes: Tables 2 and 4 indicate 58 full-time researchers who, in 1987-8, published as many as 402 publications. These are impressive data and I wonder how it is achieved?
C.L. Luh: The papers are in Chinese and many of them are generally educational brochures; about 10% of them are scientific publications.

Vegetable Production and Policy in Indonesia

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Introduction

The climate of Indonesia is characterized by a rather consistent average temperature of 27°C and atmospheric humidity around 80% R.H. at sea level throughout the year. Average temperatures naturally decline with altitude; at 1,000 m they are around 20°C.

Despite the fact that Indonesia belongs to the humid tropics, it produces a remarkable diversity of subtropical and tropical vegetables.

Highland vegetable production is not strongly commercially oriented. The commodities include mainly temperate climate vegetables such as potatoes, cabbages, cauliflower, lettuce, carrots, beans, tomatoes, onion and garlic. The wet lowland vegetables include chili, shallot, eggplants, leafy vegetables (amaranth and kangkong (*Ipomoea aquatica* Forsskal), cucumber and a wide variety of beans, are predominantly grown in all lowland coastal areas near urban metropolitan areas such as Medan, Jakarta, Semarang, Surabaya, etc.

According to the latest production estimates, in 1986 about 4.171 million t of vegetables were produced from 1,231 million ha of cropped area, excluding garden horticulture which is widely practiced and of considerable nutritional importance. The estimated total area covered about 2.3 million ha in 1969. In transmigration areas every transmigrant family is provided with ± 2 ha of land, including a 0.2 ha family garden.

The average yield of vegetables can generally be considered low. It ranges from somewhat over 1 t/ha for beans to up to 12 t/ha for cabbages.

Production of Vegetables and Government Policy

Area, Production and Yield

The area under cultivation, production and yield of vegetables in 1975 and increase of total harvested area and production in 1986 are presented in Tables 1 and 2. Following are some of the most significant changes.

Shallot. Data indicate that since 1975 the areas to shallot have increased 79%, yields have increased 34%, and **production has increased 140%**.

Garlic. Since 1975 the areas to garlic have more than tripled, yields have increased about 61%, and **production has increased more than sixfold.**

Potato. Since 1975 the areas to potato have more than doubled, yields have increased 69%, and **production has more than tripled.**

Cabbage. The areas to cabbage have increased about 85% since 1975, yields have increased about 40% and **production has more than doubled.**

Table 1. Harvested area, production of vegetables in 1975 and 1986, and index.

Commodity	Area (ha)		Production (t)	
	1975	1986	1975	1986
Potato	17,501 (100)[z]	37,628 (215)	123,875 (100)	450,825 (364)
Cabbage	23,966 (100)	44,342 (185)	317,118 (100)	820,357 (259)
Tomato	14,968 (100)	57,670 (385)	119,393 (100)	189,406 (159)
Chili	105,884 (100)	359,821 (340)	175,092 (100)	438,707 (251)
Beans	157,767 (100)	258,843 (164)	163,110 (100)	363,279 (223)
Shallot	38,946 (100)	69,579 (179)	159,379 (100)	382,117 (240)
Garlic	4,178 (100)	16,056 (384)	13,801 (100)	85,096 (617)
Others	167,665 (100)	386,529 (231)	850,693 (100)	1,440,887 (169)
Total	530,897 (100)	1,230,538 (232)	1,922,461 (100)	4,170,674 (212)

[z]Index in which 100 = 1975 value. Source: Sub Dit. Data & Statistik Bina Program Direktorat Bina Program Tanaman Pangan 1988.

Table 2. Average vegetable yields in 1975 and 1986, and index.

Commodity	Yield (t/ha)			
	1975		1986	
Potato	7.80	(100)[z]	11.96	(169)
Cabbage	13.23	(100)	18.50	(140)
Tomato	7.98	(100)	3.28	(59)
Chili	1.65	(100)	1.22	(74)
Beans	1.03	(100)	1.40	(136)
Shallot	4.09	(100)	5.49	(134)
Garlic	3.30	(100)	5.30	(161)
Others	5.07	(100)	3.73	(74)

[z]Index in which 100 = 1975 value. Source: Sub Dit. Data & Statistik Bina Program Direktorat Bina Program Tanaman Pangan 1988.

Chili. Since 1975 the area to chili has more than tripled, yields have decreased 26%, while **production has more than doubled.**

Tomato. The area to tomato has more than tripled since 1975, yields have decreased about 59% and **production has increased 59%.**

Among these vegetables cabbage showed the highest production and was followed by chili, potato, shallots, beans, tomato and garlic.

Sweet potato. The strategic importance of sweet potato in Indonesia is due to its role for crop diversification. It was planted in 230,000 ha in 1986 and produced 197 million t (Table 3). In trial fields yields as high as 57 t/ha were achieved. However, the average yield in 1986 was only 8.6 t/ha. During the period 1968-86 the total harvested area decreased to 58%, while production decreased to 83% but **yields went up 46%.**

Soybean. The area of soybean harvested in 1987 was about 1.2 million ha of which 58% was grown on wetlands and 42% on rainfed drylands. A comparison of soybean and mungbean production in 1969 and 1985 is made in Table 4. In Java, where about 80% of the national production occurs, 70% of the crop is harvested from wetlands (sawah) and the remaining 30% from rainfed drylands (tegal). Outside Java about 90% is in rainfed drylands and 10% in wetlands. In wetlands soybean is planted in the early (from March to June) and late (from July to September) dry season after rice. Soybean grown on irrigated wetlands is mainly found in East Java, Central Java, Bali and in smaller areas in Aceh, West Sumatra and Lampung.

In trial fields, yields as high as 3 t/ha have been obtained. However, in 1986-87 the average national yield was only 0.99 t/ha.

Table 3. Harvested area, yield and production of sweet potato in Indonesia, 1968 and 1986.

Commodity	1968			1986		
	Area (million ha)	Yield (t/ha)	Production (million t)	Area (million ha)	Yield (t/ha)	Production (million t)
Sweet potato	0.40	5.9	2.36	0.23	8.6	1.97

Source: PPdPTP 1988.

Table 4. Area, yield and production of soybean and mungbean, 1969 and 1985.

Crop	1969			1985		
	Area ('000 ha)	Yield (t/ha)	Production ('000 t)	Area ('000 ha)	Yield (t/ha)	Production ('000 t)
Soybean	555	0.70	389	900	0.96	870
Mungbean	80[z]	0.50[z]	40[z]	295	0.72	212

[z]1970 data. Source: DFCEPP 1988.

Government Policy

The development of vegetable production in Indonesia is directed in the first instance towards self-sufficiency of food, increasing farmers' income, improving the diet, increasing employment opportunities, supporting industrial development, accelerating exports and reducing imports.

The vegetables which provide farmers opportunities to increase their incomes are garlic, shallots, chili, potatoes and onions.

The vegetables which are considered important to increase the population's nutritional status and are easy to develop in home gardens are especially those with low cash inputs and quick yields. They are generally lowland vegetables such as tomato, beans, chili, eggplants, kangkong, spinach and cassava leaves.

Potato, cabbage, shallot, tomato and chili are considered traditional export commodities. In addition there is a great potential for export of commodities such as mushrooms, asparagus, brocolli, bell pepper and lettuce.

In order to support the development of vegetable production, the Government provides various facilities during the process of production, handling and processing of harvest, and marketing.

In order to accelerate export of nonoil commodities and to reduce imports, the Government has taken the following measures:

- to stimulate the increase of production and quality of vegetables for the domestic market as well as for export;
- to improve postharvest activities, including fresh handling and secondary processing of produce to substitute imports and increase exports;
- to stimulate the active participation of the private sector in increasing capital investments in the horticultural sector in the fields of seed production, supply and distribution, vegetable production activities and postharvest (handling, storage, transportation, processing) activities; and
- to simplify export procedures, improving market facilities and other incentive measures to stimulate exports.

Production Constraints and Steps to Alleviate Them

Efforts to increase production of vegetables have shown significant results, especially during the last 10 years. However, the increased production does not fulfill the increasing demand.

Several constraints are identified below which hamper the intensification of vegetable production. Efforts have also been taken to solve these problems.

The following are all serious constraints: the high price of seed; the high production cost; the relatively high gap between yields in research plots and the average national yield; and the high marketing cost.

High Seed Price

The high yielding varieties of vegetables are mostly hybrid, which can not be produced in the country. The supply of hybrid seed depends on import and therefore is too costly for small producers. Small farmers are able to purchase and plant seeds of local varieties which are generally of low quality and low yielding but do not require high inputs. The produce is of inferior quality and lacks uniformity. Consequently small farmers remain in a weak economic condition.

Steps need to be taken to solve this situation. Efforts have been intensified to invite foreign seed companies to develop a seed industry in the country. Producing seed in the country should be less expensive than importing seed and the varieties should be better adapted to local environments while maintaining their superior qualities. Seed produced in the country can save foreign exchange and prevent the importation of diseases and pests from abroad. Efforts have also been taken to accelerate the work of breeders to produce high-quality improved varieties.

High Production Cost

The relative high cost of vegetable production leaves a limited degree for a profit margin. The net return obtained by farmers is sometimes insufficient to motivate them to grow more. The excessive use of agrochemicals such as fertilizers, pesticides and growth regulators has added more input expenditures and causes serious pollution to the soil, water and produce.

More efficient pest control measures should be developed as an integrated pest control package. Insecticide needs to be applied only if necessary and in the minimum quantity required for effectiveness. Developments in the field of biological control should be tested for possible adaptation and application; provided there is sufficient staff, equipment and facilities supporting it. Research needs to be directed to determine the actual need for fertilizer, pesticide and growth regulators, based on soil analysis, population dynamics of the insect and field surveys.

High Yield Gap

Research has successfully produced technological packages for increasing vegetable production. However these are not fully applied by farmers. These discrepancies are reflected by the difference in the yield obtained in the research plot and the average national yield. These yield gaps could be narrowed through technology transfer activities. Constraints in intensifying the transfer of technology are: the limited supply of technology packages which are ready for use and can be recommended; a lack of funding for multilocation trials; and a lack of funding and of know-how of personnel causes a slow rate of adoption of the recommended technology by farmers. The limited skill and know-how of the extension staff in the field of horticulture is another limiting factor in transferring technology.

In order to alleviate these limitations, the following steps need to be taken. More trials in farmers fields, demonstration and pilot plots need to be conducted. Cooperation with the extension staff needs to be strengthened to develop proper motivation of the farmers toward adoption of the new technology. Field days and field visits should be organized regularly to evaluate the effectiveness of the transfer. More training should be carried out to upgrade the skill and know-how of the subject matter specialists and the field extension workers.

High Marketing Cost

The high marketing cost is another constraint for production. The marketing organization in the production center is relatively poor. Improper handling causes a high percentage of loss. The infrastructure in the production area is not conducive for development and marketing. Transportation costs are high due to the small-scale, scattered and unorganized situation of the producers. Therefore, generally farmers obtain only a small share of the retail price.

To improve the situation the following steps have been taken. Farmers are being motivated to be active members of their cooperatives and, together with farmers' groups, to take a more active part in marketing efforts. To minimize postharvest loss and maintain the quality of produce, appropriate technology packages will be adapted, including grading, packaging, transportation and storage. Efforts will be taken to organize farmers into commodity groups to establish larger and more compact planting areas. This system will enable farmers to be more accessible to the market and extension services.

One of the cases where such efforts have shown some promising results is in the production of garlic. Steps have been taken to alleviate constraints such as inadequate production and distribution of high-quality seed, lack of adoption of adequate production technology, insufficient supply of inputs, lack of credit facility and poor marketing mechanism.

Seed of improved varieties was multiplied by farmers with the guidance of the extension service. Seeds were distributed through the farmer's association in cooperation with a state-owned company, Pertani. Technological packages were demonstrated in farmer's fields in the production centers. Farm inputs, including pesticides and fertilizers are supplied by Pertani. The credit required by farmers is extended by the Government Bank through special credit arrangements. To assist the farmers in improving the marketing process and to maintain a profitable price for garlic, state-owned companies were assigned to actively provide valuable guidance and cooperation. In order to expand the production area, a plan was implemented to develop new production centers located in suitable agroecological environments in the highlands of Central Java, West Java, South Sumatra, Jambi, and South and North Sulawesi Provinces. In addition, new centers located in the lowlands near the urban areas have been explored. The area harvested increased from 3,900 ha in 1981 to 12,640 ha in 1985. Garlic yields increased significantly from 1,130,000 t in 1981 to 4,900,000 t in 1985.

Sweet Potato Constraints

There are four problem areas limiting sweet potato productivity, i.e. socioeconomic, agronomic, utilization and postharvest. The socioeconomic constraints include: unreliable market, the crop is not a major component of the diet, it is considered a 'poor man's' food, and the lack of efficient production technology. The agronomic constraints consist of: a lack of suitable varieties for specific requirements of industry, minimum use of fertilizer, grown on marginal areas with minimum input, and suitable technology for different cropping systems is not available. A utilization constraint is the lack of variability in the form of the end product to be consumed. There are numerous postharvest problems.

Although considerable results have been obtained through various research efforts, many important problems and challenges remain to be solved. The priority area for future research collaboration involves: (1) exchange of germplasm and breeding materials; (2) breeding for resistance and environmental stress; (3) postharvest, including secondary processing to diversify end product; and (4) marketing and prospect studies.

Soybean Constraints

Yield improvement of grain legumes, including soybean, lags behind other food crops such as rice and corn. The following factors impose limits on productivity:

- Soybean does not respond as well to fertilizer as does corn or rice;

- Soybean produces seed which is rich in protein and needs more photosyathate than does the carbohydrate predominant rice or corn seed;
- Soybeans are infected by many pests and diseases;
- Soybean has a short stem which succumbs to weed competition;
- Under dryland conditions the crop is subjected to environmental stresses such as drought, flood and mineral deficiency/toxicity;
- The level of production technology is not fully developed; and
- Day length is relatively short (12 h), which prevents breeders from developing a 'full season variety' for maximizing yield.

Constraints to grain legume productivity in general can be classified into socioeconomic causes and agronomic constraints (including biotic and abiotic factors).

Socioeconomic constraints. The following socioeconomic constraints have been identified:

a. high risk in applying inputs;
b. unreliable marketing system;
c. inputs are not readily available;
d. inadequate extension service over scattered production areas;
e. soybeans are not a major part of the local diet;
f. lack of experience in growing the crop;
g. lack of equipment for efficient production; and
h. lack of cooperation among growers.

Agronomic constraints. The agronomic constraints, including biotic and abiotic factors are:

a. suitable varieties are unavailable;
b. insufficient high-quality seed;
c. use of minimum tillage produces a poor crop;
d. poor stand due to poor seed viability, pests and diseases;
e. minimum fertilizer available;
f. growth on marginal areas with low input and management;
g. inadequate moisture or excessive water with poor drainage;
h. poor modulation due to ineffective Rhizobium strain or lack of Rhizobium;
i. weed competition, insect and disease damage;
j. suitable technology for different cropping systems not available; and
k. nutrient deficiency/toxicity.

The common problems, however, are seed germination, crop establishment, soil drainage, weed competition, biological nitrogen fixation, water logging, drought and soil compaction, pests and diseases, seed damage by rain, mineral deficiency or toxicity, rodent damage, heat stress and lack of suitable technology.

Areas for an Effective Collaboration

Collaboration with the international agriculture research centers, such as the Asian Vegetable Research and Development Center (AVRDC), has been underway for the last decade. Exchange of germplasm material has been facilitated. Some of the local officially released varieties of tomato were selected from AVRDC's genetic material. After the release of the above-mentioned varieties for lowland production, LEHRI has continued to evaluate more suitable varieties for both highlands and lowlands, for fresh consumption and for canning and processing purposes. Breeding lines were also introduced from the USA for trial and selection. A collaborative Research

Project on Vegetables was initiated with AVRDC, funded by the Asian Development Bank, in 1980. Various entries of Chinese cabbage, and cauliflower from AVRDC were also evaluated for possible adaptation.

We have also evaluated and released four mungbean and four soybean lines either developed by AVRDC or with an AVRDC parent. Two AVRDC-developed Chinese cabbage cultivars have been released for farmers' use after testing and adaptability trials. The approximate area grown to AVRDC soybean varieties in 1987 was 360,000 ha or 30% of the total area under soybean cultivation in Indonesia (Sumarno 1988).

Based on the results until now, it is apparent that more intensive research needs to be done, especially in developing tomatoes resistant to bacterial wilt which is prevalent in the lowlands and *Phytophtora* sp., *Alternaria* sp. and *Cercospora* sp. which commonly occur in the highlands. Chinese cabbage which is resistant to clubroot (*Plasmodiophora brassicae* Woronin) needs to be developed, using materials with broader genetic variance for resistance to the disease. To reduce the production cost for shallot, there is a possibility to grow shallot using seed rather than bulb. However, the technology requires more research. The virus diseases attacking chili pepper still significantly decrease yield. Therefore, the development of varieties tolerant to these virus diseases needs a special effort. Several introduced varieties of onion produce well in the highlands. However the storage capability of the onion is relatively short and remains a serious constraint which needs to be resolved.

Our research cooperation with the International Potato Center (CIP) and the Southeast Asian Program for Potato Research and Development (SAPPRAD) on potato has produced significant results in developing technology for growing in highland and the midlowland areas. Several varieties have been identified and developed for this purpose. Seed potato production technology has been furthered by use of rapid multiplication techniques and meristem culture. Efforts have been made to promote participation of private seed growers to produce high-quality seed potato in the country. However it is felt that more research is needed to develope better high yielding varieties that have additional disease resistance and better tuber quality for processing purposes.

A collaborative research project has been started with the Dutch Government on strengthening research of lowland vegetables, including germplasm development and evaluation, developing high yielding varieties resistant to disease and pests of tomato, cucurbits, alliums, leafy vegetables and leguminous vegetables which are better adapted to the lower elevations where human nutrition needs are the greatest [illegible] also includes research in seed production and technology, diseases and pests, soil fertility [illegible] postharvest technology.

Notwithstanding the existing cooperative research activities, a broader collaboration is felt necessary because of the following reasons.

- Recently most improved vegetable varieties have been derived from countries which are not located in the tropics. These varieties tend to show poor adaptation to our local environmental conditions, due to differences in climatical conditions, pests and diseases, as well as cultivation methods;
- Most of the newly improved varieties are not of the open-pollinated type. They are mostly hybrids, which do not allow us to produce the seeds for further development;
- To break the yield plateau barrier of vegetables, it is necessary to have facilities for the safe exchange of breeding materials with a rather broader genetic variance;
- More exchange of information is needed concerning research results on the varietal performance in various countries, especially results regarding resistance to pests and diseases prevailing in the tropics;
- More opportunities are needed to share the various significant technology adaptation for vegetable growing in the tropics;
- To increase the effectiveness and efficiency of research, a profesional external review needs to be conducted;
- The exchange of views and experiences is needed on the effective transfer of technology achieved by various vegetable research institutes;

- A more coordinated effort needs to be undertaken to enable better achievements in finding reliable sources of research funding; and
- A more effective mechanism is felt necessary to address similar regional problems or issues, experienced by vegetable research institutes.

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Research on Vegetables in Indonesia

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Introduction

Under Pelita IV (Five Year Development Plan, Phase IV) agricultural development is aimed at self sufficiency in rice to increase farmers' income, to improve the nutritional level of the people, to increase employment opportunities, to increase export earnings and reduce imports of agricultural commodities, to support industries processing agricultural products and to optimize the productive utilization of natural resources while protecting environmental quality and stimulating harmonious rural development. To meet these objectives, vegetable crops have a very important role not only as a source of high nutritional value food but also to promote agricultural industries and minimize imports, especially garlic and to a lesser extent onions. However, there are still many constraints that must be resolved in the effort to increase vegetable production.

The most important constraint in vegetable production is the availability of high-quality seed. High-quality vegetable seed is mostly imported. Unlike rice seed which is produced by Perum Sang Hyang Sri, there is no company engaged in vegetable seed production in Indonesia.

The second constraint is the high cost of production due to the excessive use of fertilizers and pesticides. Moreover, the excessive use of nitrogen may cause crop susceptibility to certain diseases and may create problems of potassium and sulfur availability. Unwise use of pesticides may cause pest resistance, resurgence, and the disappearance of natural enemies such as predators and parasitoids.

Since vegetable crops are mostly perishable, the third important problem that must be solved is yield loss and quality decline as a result of improper handling. The perishable characteristic of vegetable crops cause sharp price fluctuations, even during one single day. Better handling and processing may overcome this problem.

Another problem that may rise in the future is land erosion due to the expansion of the vegetable production area in the highlands by opening the forest. To overcome this problem, the Lembang Horticultural Research Institute (LEHRI) is now concentrating on lowland vegetable research, including adaptation of highland vegetables to lowland or midelevation areas.

Based on the constraints faced, the objectives of vegetable research are to develop improved technology and socioeconomic packages, in order to support vegetable production, increase quantity, improve quality, meet nutrition needs and increase farmers' earnings and foreign exchange earnings, job opportunities and natural resource conservation. Within the Agency for Agricultural Research and Development (AARD) organization, research for vegetables is mandated to LEHRI.

Important Vegetable Crops in Indonesia

As a consequence of the high population growth rate (2.3% annually) and of economic development, commercial vegetable growing is a rapidly expanding sector. About half of the total vegetable production in Indonesia is destined for the commercial market. In 1986, Indonesia produced some 5.5 million t of vegetables; this comprised about 5% of the total value of agricultural production. Up to 1982 vegetable imports (mainly garlic and, to a lesser extent,

onions) annually totaled about 28,000 t. Since 1983 the Government of Indonesia restricted certain vegetable imports in order to conserve foreign exchange and encourage domestic production (AARD 1988).

For many years considerable efforts had been concentrated on increasing the production of highland vegetables and less attention had been paid to lowland vegetables (LEHRI 1987). Consequently, since 1984 lowland vegetables have received much more attention within the total horticultural research framework. The reason for this change is that the potential vegetable production area is much greater in the lowland area than in the highland area. In the current production area (see Table 1), lowland vegetables are also now prominent. Futhermore, a further extension of highland vegetable production may create soil erosion which is contrary to one of the goals (environmental conservation) of the agricultural development program.

Table 1 indicates that AVRDC principal vegetables such as Chinese cabbage, chili and tomato, occupy large areas, especially chili at 256,000 ha followed by tomatoes 48,000 ha and Chinese cabbage 24,000 ha.

Table 1. Important vegetable crops in Indonesia, 1985.

Crop	Highland/ lowland[z]	Area ('000 ha)	Production ('000 t)	Yield (t/ha)
Chili	L (H)	256	511	2.0
Onions:				
a. Shallots	L (H)	77	380	4.9
b. Garlic	H	12	59	4.8
c. Bunching onion	H	23	101	4.3
Potato	H	29	283	9.7
Tomato	H (L)	48	151	3.2
Beans:				
a. Yard-long beans	L	196	311	2.0
b. French beans	H	29	93	3.3
c. Red beans	H	56	58	1.0
Cabbages:				
a. White cabbage	H	36	520	14.5
b. Chinese cabbage, Mustard	L	24	165	3.3
Eggplant	L	75	193	2.6
Cucumber	L	67	268	4.0
Kangkong	L	37	136	3.7
Amaranths	L	36	82	2.3
Gourds (cucurbits)	H (L)	20	99	4.9
Carrot	H	6	38	6.2
Chinese radish	H	3	22	6.4
Others	H + L	14	50	3.6
Total		1,044	3,520	–

Source: DPH 1985. [z]Parenthesis indicate widely grown, either in lowland or highland area.

Mandate of LEHRI

LEHRI is one of 22 research institutes under AARD. It is responsible for research and development of vegetable and ornamental crops. In the implementation of its mandate, LEHRI is supported by three substations, i.e., substations for Horticultural Research at Segunung, Cipanas and Berastagi.

Segunung Substation conducts research on pests, diseases and nematodes for vegetable and ornamental crops. Cipanas Substation undertakes ornamental crop research, with the exception of pest and disease research. Berastagi Substation conducts research on commercial vegetables, especially on vegetables which are exported to Singapore and Malaysia.

To ensure that vegetable research contributes to the achievement of the agricultural development goals, priorities have been discussed and established during the Advisory Committee Meeting. The first priority is devoted to those commodities which are of political and economic strategic importance such as chili, garlic, shallot and potato. The second priority is devoted to those commodities which will generate social and environmental benefits (new employment opportunities) through the development of agricultural industries, better nutritional levels for the people and the preservation of natural resources. The list of vegetable research suggested by the Advisory Committee Meeting is shown in Table 2.

Table 2. Vegetable research and disciplines in LEHRI.

Commodity	Discipline[z]							
	PB	A	E	PP	PH	SP	AE	CS
Chili	***[u]	**[y]	**	***	***	*	*	**
Garlic	*	***[x]	*	**	**	**	**	*
Shallot	*	**[x]	**	**	***	**[w]	*	*
Potatoes	*[v]	**[x]	*	***	*	***	*	**
Tomatoes	**	**	*	*	**	*	*	*
Legume	*	**	*	**	**	*	*	*
Crucifers	***	*	**	**	**	*	*	*
Lowland vegetables (amaranths, kangkong, cucumber, eggplant)	**	**	***	***	*	*	*	*
Commercial vegetables (bell pepper, carrot, asparagus)	***	**	*	**	**	***	*	*

[z]PB = plant breeding, A = agronomy, E = entomology, PP = plant pathology, PH = postharvest, SP = seed production, AE = agroeconomy, and CS = cropping systems. [y]Off-season production. [x]Cultural practices for lowland production. [w]True seed/botanical seed. [v]Processing variety. [u]The number of asterisks indicates importance.

Vegetable Research Constraints

Biotic Constraints

There are many factors limiting optimal growth and yield of vegetables in Indonesia. The most important biotic constraints are seed quality, crop nutrition, pests and diseases, weeds and species diversity. Of these factors the quality of seeds is the most critical.

Seed quality. Only about 5% of the total area of commercial vegetables is planted with improved seed; this seed is entirely imported. The remaining 95% of the vegetable growing area is planted with low-yield varieties. Due to the absence of a vegetable seed industry, the vegetable seeds produced by local farmers are of a lower quality than imported ones (LEHRI 1985).

Pests and diseases. Pests and diseases in vegetable crops are considered to be the principal factors limiting the productivity of several important vegetables. However, only very limited information on crop losses and the proper control methods of pests and diseases are available. The present emphasis of pest and disease control in commercial vegetables relies on chemical control. The limitations and drawbacks of pesticide usage have provided a stimulus to put more effort in developing and implementing integrated pest management (LEHRI 1988).

Weeds. Weeds are one of the limiting biotic factors in vegetable production, especially vegetables which are grown in the upland areas such as potato and dwarf bean. The yield reduction

due to weeds for potato (Abidin and Suwahyo 1984a) and dwarf bean (Abidin and Suwahyo 1984b) is about 33%. The most common protection method used by the farmers is hand weeding.

Species diversity. Within Indonesia there is tremendous diversity of species of vegetables, as well as fruits and ornamentals. Vegetable crops may be found at many different altitudes, soil types and climates. Due to the limitation of funds and man power, all research activities are directed to overcome the key problems on priority crops.

Abiotic Constraints

There are three major constraints in producing optimal vegetable crop yields, namely the soil (physical properties), crop nutrition and environmental conditions.

Soil condition. The physical properties of the soil is an important factor for water economy and nutrition uptake. Poor water supply or drainage will affect the growth and yield of vegetable crops and the incidence of soil-borne diseases. Many vegetable crops are grown in steep or hilly areas. This situation, of course, offers a great challange to prevent and overcome soil erosion.

Crop nutrition. The soil quality, structure, pH, drainage and aeration in the highlands, as well as in the lowlands, vary greatly. Growers tend to use high dosages of fertilizers, especially of urea that might induce the incidence of pests and diseases. Knowledge of the optimal dosage of nitrogen and other fertilization, and the effect of liming on acid soils is lacking.

Environmental conditions. The climate in Java, Bali, Sumatra and Sulawesi, in which vegetable crops are produced, is normally hot and moist in the lowlands and warm or cool and moist in the highlands. Consequently, the high-quality vegetable seed which is mainly imported from subtropical countries is only suited for the highland areas. In the lowlands the farmers use their own seed which is inferior. In these areas which have a marked dry season, vegetable field crops are often irrigated. If the water supply is sufficient, vegetable crops are grown on a year round basis. This allows for continuous reproduction of insect pests and pathogens. These are, in fact, the main factors limiting the productivity of several important vegetable crops.

Current National Vegetable Research Program

Vegetable research is divided into two locations: highland vegetables and lowland vegetables. Research on highland vegetables stresses varietal improvement, seed production technology and conservation of soil fertility and environment. Research on lowland vegetables is concentrated on increasing production and improving quality of high-value vegetables such as shallots, chili, cucumber and vegetables containing many vitamins such as amaranths, kangkong, yard-long bean and tomatoes.

Highland Vegetables

Highland vegetables will be tested for adaptation in the midlowlands, especially high value vegetables such as garlic, potatoes and green beans. Research and development of lowland vegetables is also meant to develop crop diversification in the rice-based farming system.

Vegetable research is concentrated on seven potential commodities: chili, garlic, shallot, potatoes, tomatoes, pulses, crucifers, lowland vegetables (amaranths, kangkong, cucumber and eggplant) and commercial vegetables (bell pepper, carrots and asparagus).

Chili. Research on chili is directed to varietal improvement, off-season production, control of pest and diseases, fresh handling, demand and supply.

Garlic. Garlic is grown in the highlands between 700-1,600 m above sea level and is a high input crop. This situation may endanger environmental and natural resource preservation. Therefore, research on garlic is directed to the development of lowland garlic production, especially in the rice-based cropping system to increase the income of rice farmers. Research on disease control, especially viruses, through the production of virus-free seed has been initiated.

Shallot. The hign cost of production due to high input (seed, fertilizers and pesticides), high-yield loss due to improper storage and low price are the problems faced by the farmers. Therefore, the research on shallot is directed to: reduce the cost of production by introducing botanical seed; proper usage of fertilizers and pesticides; reduce yield loss by improving the storage; and increase the price by involving cooperatives (KUD).

Potatoes. The constraints to potato production are similar to those of garlic and shallot: availability of high-quality seed, high cost of production and negative impact to the natural resources due to high inputs. Therefore, research on potato is directed to produce disease-free potato seed, varietal improvement, especially for industrial purposes, and midelevation production (heat and bacterial wilt tolerance).

Tomatoes. Price fluctuation is the most important problem faced by the farmers. High supply during the dry season and low supply during the rainy season causes big price differences. Tomato research is concentrated on production in the rainy season. This research includes the development of varieties which are resistant to high humidity, diseases and development of appropriate cultural practices. Postharvest handling and processing tomatoes that minimize price fluctuations are also taken into consideration. However, in line with the policy of developing lowland vegetables, the development of heat-tolerant and bacterial wilt-resistant varieties has been intensified.

Legumes. Leguminous vegetables are a very important sources of protein and support the government's policy for the improvement of the nutritional levels of the people. Nevertheless, there are still numerous problems in the production process that must be solved. The improvement of cultural practices, reduction of yield loss due to pests and diseases, and seed storage are the most important research areas for leguminous vegetables.

Crucifers. White cabbage, Chinese cabbage, cauliflower and radish are the crucifers which are widely grown in Indonesia. The constraints faced are that the seeds are being imported, pests (*Plutella xylostella* and *Crocidolomia binotalis*) and disease (*Plasmodiophora brassicae*). Research on crucifers is directed to the production of crucifers in the lowland areas and include the improvement of local varieties and cultural practices, and integrated control of pests and diseases.

Lowland Vegetables

Lowland vegetables include vegetables which are widely grown in the lowland, rather than highland, areas such as amaranths, kangkong, cucumber and eggplant, and include chili, legumes and shallot which have already been mentioned above. Until Pelita IV, research on these lowland vegetables, except for chili, shallot and legumes, was neglected. Research on lowland vegetables is concentrated on varietal improvement, cultural practices (including pest and disease control), postharvest handling (either fresh handling or processing) to increase the added value of lowland vegetables.

Commercial Vegetables

Commercial vegetables are vegetables with a high price, but limited market, such as asparagus, radish, carrot and bell pepper. Research on commercial vegetables is concentrated

on varietal testing and quality improvement to meet the demand of hotels, supermarkets or for export. Quality improvement could be accomplished by changing to a variety which is more acceptable, better cultural practices and better fresh handling.

Manpower for Vegetable Research

At present the number and education qualification of researchers at LEHRI is still very limited (Table 3). The strongest discipline is agronomy. Since there will be no additional recruitment, long-term training is required to fulfill the need. The weakest dicipline are agroeconomy and postharvest. New recruitment or reallocation within AARD and long-term training are still needed.

Table 3 Present manpower at LEHRI for vegetable research and future needs.

Discipline	At present			Future needs		
	PhD	MS	Ir	PhD	MS	Ir
Plant breeding	1	1	12	5	9	13
Agronomy	1	8	10	5	7	7
Entomology	1	3	4	4	4	2
Plant pathology	1	8	3	11	15	8
Postharvest	–	1	3	3	6	6
Agrosocioeconomy	–	2	1	3	5	5
Total	4	23	33	31	46	41

Research Funds

Before 1985 most of the research funds came from the Government and only a small amount was obtained from other sources such as tropical potato production from the Southeast Asian Program for Potato Research and Development (SAPPRAD), virus-free potato seed production from the United States Agency for International Development (USAID), etc. Because research funds from the Government have been decreasing since 1985, other sources of funds have been explored. At the present time, research funds are being obtained from: the Government of Indonesia, the Dutch Government for lowland vegetables, SAPPRAD for tropical potato production, USAID for cucumber mosaic virus study, and private companies for pesticide and fertilizer studies.

Research Collaboration

The bilateral programs between AVRDC and Indonesia have proved to be a productive research network. Among other benefits of this collaboration for the Indonesian farmers is the development of improved vegetable crops such as tomatoes, Chinese cabbage and amaranths. Some vegetable crops that have been improved and developed by AVRDC scientists have made a significant contribution to the country. AVRDC tropical tomato breeding varieties, namely Ratna (VC 11-1), Intan (AVRDC 33) and Berlian (VC 8-1-2-7) have been released during Pelita III and IV. These cultivars have consistently proven to be superior to local varieties in the lowlands and resistant to bacterial wilt. During Pelita III, two Chinese cabbage varieties, i.e. Sangihe (AVRDC No. 77 M(3)-26) and Talaud (77M(3)-40) were also released for the lowlands.

AVRDC-improved mungbean and soybean legumes have also provided substantial benefits for the Indonesian farmer. Several mungbean, i.e. Manyar (VC 1089A), Nuri (V 2773), Walet (VC 1163A) and Gelatik (VC 1160-22-2B-1-B), and soybean, i.e. G 2120 (G 2120), Wilis (G 2120

parent), Kerinci (AGS2 parent) and Tidar (G2120-M), varieties have been released over the last decade. Approximately 30,000 ha of AVRDC-improved mungbean and 360,000 ha of AVRDC-improved soybean were grown in 1987 or 12% and 30%, respectively, of the entire national production (Sumarno 1988).

Under the AVRDC-Indonesia Bilateral Programs, five Chinese cabbage hybrids, i.e. Hybrid 62, 80-32, 80-13, 80-6 and 58, were obtained. All of the above-mentioned hybrids are promising for lowland areas. Several lines of tomatoes have been identified which are suitable for lowland production such as LSU37-7-0, Berlu, LG153-553 and LG154-858.

However, to strengthen national research programs, the role of AVRDC needs to be amplified, especially in the effort of fund generation (grant) from donor countries to finance research activities, transfer of technology and training.

Research Fund Generation

Budget allocations for vegetable research have declined very sharply since 1985 due to the economic situation faced by the Government of Indonesia. To provide a satisfactory and stable level of financing for research activities, AARD has already encouraged all research institutes to seek other sources of long-term financing through long-term collaborative agreements with the private sector. However, to stimulate this kind of collaborative agreement a catalytic fund is needed. One example, which is now under preparation, is a project for the production and distribution of virus-free potato seed project that will be financed by a grant from the Japan International Cooperation Agency (JICA). Virus-free plantlets and potato stem cuttings will be produced by LEHRI, while the Government Seed Farm (BBI) will produce small tubers from stem cuttings provided by LEHRI. The small tubers, then will be multiplied by a private company (in cooperation with the farmers) to produce extension seed. It is expected that within five years the private company will have established itself and replace JICA's financing of the activities. A similar scheme is being implemented through a lowland vegetable project financed by the Dutch Government to produce high-quality seed for lowland vegetables.

Research Areas

Among vegetables prioritized by LEHRI, lowland vegetable research (chili, shallot, yard-long bean, cucumber, eggplant, amaranths and kangkong), has been already strengthened by the Dutch Government grant, and potato, especially research on lowland potato production, has been supported by SAPPRAD and the International Potato Center (CIP). The research which needs to be strengthened is listed below.

Crucifers. Strengthen local variety improvement, control of club root (*Plasmodiophora brassicae*) and seed production.

Bell pepper. This vegetable requires strengthening of seed production and cultural practices.

Radish. Radish requires quality improvement through varietal and cultural practices improvement.

Carrot. Carrot needs quality improvement through varietal and cultural practices improvement.

Garlic. Garlic is in need of varietal improvement and virus-free seed.

Asparagus. This vegetable needs assistance for varietal testing and seed multiplication.

Technology Transfer

The mandate of LEHRI is not only research but also the development of vegetable and ornamental crops. The greater the linkage and integration between policymakers, basic scientists, applied vegetable researchers, the private sector, agribusiness operators and the agricultural extension service, the higher the probability that the vegetable research will be well directed, technically sound, marketable and is in a form which permits rapid diffusion to the farm community. The greater the communication between AVRDC scientists and national scientists, and among national scientists, the higher the capability of the national researchers to make better research programs. To achieve this goal AVRDC is required to coordinate meetings such as seminars, workshops, etc. held not only at AVRDC, but also in other places depending on the subject, i.e. seed technology seminar in the Philippines, integrated pest management in Indonesia, etc.

Training

Training conducted by AVRDC should be directed to the subjects which could improve the capability of junior researchers such as research methodology, experimental design, field and laboratory experiment, home garden experiments, etc. Vegetable production training should be conducted by the country whose climatic condition represents several countries and AVRDC would be the backstop institute. Or the training could also be conducted by the country which has a comparative advantage in a certain subject, i.e. Thailand for vegetable production training, the Philippines for seed production training, the Philippines for seed production training, Indonesia for integrated pest management, etc.

Conclusion

Vegetables have a very important role to support the achievement of agricultural development goals. However, there are still a number of constraints which must be solved at the same time that allocated funds from the Government are decreasing. To overcome this situation, AVRDC is required as a backstop institute to help national research institutes in seeking other sources of funds to finance research, transfer technology and conduct training activities that will be done at AVRDC or in Indonesia or in other countries depending on the objective of the activities.

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Discussion: Current Status — Indonesia

R.M. Nor: What is the success rate in getting highland varieties adapted to the lowlands and in which crops has this been the most succesful?
A.A. Asandhi: Some varieties of potatoes have been successfully adapted to the lowlands: 'Cosima', 'Cipanas', 'Famosa', etc. Cabbage varieties imported from other countries such as KK cross KY cross are already grown by the farmers.

J.-Y. Yoon: Would you kindly provide us with information on vegetable research man power in the institutions and universities other than LEHRI?
A.A. Asandhi: There are 5 PhDs from the University of Padjadjaran and 5 PhDs from Bogor Agricultural University are working on vegetable research. The institutes are given in my paper.

R.M. Nor: What are the proportions of chili grown for fresh, processed and dry purposes in Indonesia?
Subijanto: It is difficult to identify chili for processed and dry purposes from the total production but most of the production is for fresh, and a little for dry, purposes.

N.S. Talekar: Export is one of the objectives in vegetable research and production. Is the per capita consumption in Indonesia high enough to justify emphasis on export?
Subijanto: Although the per capita consumption is low, there is a need for exports to increase foreign exchange earning for the country and to accelerate efficient vegetable production.

R.V. Valmayor: Indonesia scored successes in bringing potato production from the midlands to the lowlands. Have you observed differences in performance of lowland potato at different latitudes?
Subijanto: We will take this into consideration for planning the trials next year.

N. Amerasinghe: It is customary for meetings of researchers to claim all the benefits of production increases. The data given in the paper belie the contributions of extension, credit and government policy. Could you kindly elaborate on the contributions of the other factors/actors?
Subijanto: The benefits are due to the accumulative and interactive effect of various factors, but are difficult to quantify.

M. Kamiya: If my memory is correct, in the beginning of the 1960s the exports of vegetables from Indonesia to Singapore suddenly declined due to political reasons, and the share of Indonesian vegetables in the Singapore market has still not recovered since then. I think this situation has been brought about by the competition in the market with vegetables from Malaysia, Taiwan and Australia, especially competition in quality. Is my observation correct?
Subijanto: Recovering a lost market and price/quality competition is a challenging problem to accellerate export.

M. Kamiya: According to statistical data, the export of vegetables from Indonesia has been rather stagnant in the 1980s, compared with the increase in production. Has domestic consumption increased in this period or is the weakness in the competitive position of Indonesia a major reason for the stagnant exports?
Subijanto: The competitiveness of Indonesian vegetables in the export market has had more influence rather than the increasing demand.

Hashim B.A. Wahab: What has contributed to the rapid expansion in the production of shallots, potato and cabbage?
Subijanto: The critical factors are technology, effective expansion and favorable prices.

C.Y. Yang: Dr. Subijanto has a good point in his statement to point out the importance of international crop nursery trials (multilocations). As a matter of fact, AVRDC does have international nursery trials for its principal crops. However, it takes time and funds to set up one crop at a time. Of course as you already know and have experienced, we have a mungbean international trial nursery, an international soybean trial nursery for yield and another one for soybean rust. We are currently trying to organize and establish the international pepper trial nursery, international sweet potato nursery and others as the time and our research arrangements are ready.

P.A. Batugal: It is enlightening to note the gains and advances made by Indonesia in vegetable research and development. However, I note that the problems presented by Indonesia can be categorized into the following: (1) researchable problems, i.e. suitable varieties, pest management; (2) development problems, i.e. storage, handling and transport, training, seed production; and (3) policy issues, i.e. marketing, funding. I hope that as in the case of the Indonesian situation, we can assess and categorize the problems and issues presented by the other countries so that we can isolate those which are researchaole (not all problems can be solved by research), those whose solutions are development in nature, and those whose solutions are policy-based. This will enable us to face the national and common regional problems appropriately and effectively.

Vegetable Production and Policy in Thailand

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Introduction

Thailand is an agricultural country with a total area of approximately 51.3 million ha. More than 20 million ha is devoted to agricultural production, of which rice is the predominant crop. Rubber, maize, cassava, sugarcane, kenaf and soybean are also important crops. Fruits and vegetables are widely grown. Geographically, the country is divided into four regions according to the differences in annual temperature and rainfall (Table 1). The following three seasons are pertinent to all these regions: the hot season from late February to May, the rainy season from late May to October, and the cool season from late October to February.

Thailand's ability to produce large quantities of tropical vegetables, fruits and orchids has long been evident. Vegetable production fluctuates like other crops from year to year due to the farming methods which are dependent on the weather and farm prices which vary greatly. In recent years many varieties of vegetables have been adapted to Thailand's soil and weather conditions and have been very successful, both in the local market and abroad. Although the primary interest is for the local market, these products are expected to have great export potential.

Table 1. Average annual temperature and rainfall in the four regions of Thailand.

Region	Annual temperature (°C)	Annual rainfall (mm)
Northern	26-27	1,254
Northeastern	26-27	1,300
Central	27-28	1,433
Southern	27-28	2,279

Vegetable Production

Area

The total area planted to vegetables in Thailand, as recorded by the Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, from 1981 to 1986 is shown in Table 2. The area planted to 27 crops in the last six years averaged about 308 thousand ha. This estimation excludes those vegetable crops that are irregularly cultivated such as cantaloupe, watermelon, white potato and other temperate species. About 4.1% of the vegetable land is located in the central plain which covers the West and East Provinces, whereas the Northeastern and Northern Regions devote 25.5% and 24.9% of their land, respectively to vegetable production. The Southern Region provides the smallest area for vegetable growing because most of the cultivated land is involved in pararubber.

The total planted area to vegetables since 1981 has varied from 328,000 to 276,800 ha. There has been a decreasing trend since 1984. This is probably due to alteration of land use, substitution for alternative crops, etc.

Like other horticultural crops, vegetables are usually grown in suburban areas. This is because most vegetables are highly perishable and intolerant to mechanical damage during transport.

Table 2. Area planted to vegetables in Thailand, 1981-87.

Year	Total	Damaged	Harvested
	('000 ha)[1]		
1981	328	6.4	322
1982	328	6.4	322
1983	326	4.8	322
1984	314	8.0	306
1985	306	4.8	301
1986	277	1.6	275
1987	278	1.6	277
Average	308	4.8	304

[1] 1 ha = 6.25 rais Source: Anonymous 1981-86.

In addition the poor postharvest technology and limitation of cold storage makes vegetable growing in suburban areas advantageous because of the better transport and marketing facilities. Urban sprawl is forcing vegetable growers to leave their lands or alter their land use away from vegetable production into other businesses.

Other alternative crops have been grown in Thonburi Province. Many vegetable growers shifted their crops from leafy crucifers to fruit trees and ornamentals, because the successive planting of vegetables in the same location brought about an accumulation of diseases and pests which were so serious that the vegetables could no longer be commercially cultivated. Some growers shifted into other enterprises in which the area of cultivation is not recorded such as bamboo shoot processing where almost all of the raw materials are obtained from the wild and others became engaged in mushroom production. These are some of the reasons the area planted in 1986 dipped to 277,000 ha.

There should be a small increase in the cultivated area within the next few years. This is due to several dynamic policies which have been implemented by the government to stimulate the economy. The policies include the promotion of fresh vegetables, as well as their processed products, for export. Today, vegetables and products from the tropics have good prospects because they have become well known in many Western countries. This is indicated by their increase in export value (Table 3). Many private companies are now expanding their export activities to vegetables and fruits. This should signal an expansion in the area planted to vegetables.

Production

Vegetable growing in Thailand has not progressed very much from traditional practices and cultivation techniques need improvement in order to raise overall yield per planted area. The production of vegetables during the last six years, 1981-86, varied from 2.00 to 2.22 million t with an average of 2.08 million t (Table 4). However, native or wild vegetables which are extensively available in nature are excluded in these figures.

Table 3. Exports of various vegetable products, 1984-85.

	1984		1985	
	Volume (t)	Value[2] (US$)	Volume (t)	Value (US$)
Dried salted vegetables	699	876,120	652	1,477,840
Canned baby corn	4,482	4,045,240	6,281	5,658,760
Canned seasoned vegetables	9,166	4,225,720	16,737	4,372,120
Seasoned vegetables	21,076	8,742,080	23,606	10,958,440
Vegetable juice	9	112,800	68	51,520

[2] US$1.00 = 25 baht. Source: Anonymous 1986b.

According to the area planted, chili, bird pepper, garlic, shallot, cucumber and yard-long bean are the predominant cultivated crops (Table 5). Chili and bird pepper are widely grown throughout the country and the produce mainly supplies the local market with a small portion for export as both fresh fruit and chili powder or chili paste. Several types of eggplants are extensively planted year round. Tomato, another solanaceous plant, production has been concentrated in the Northeastern Region from December to March and off-season planting is common in the central plain.

Garlic, shallot and onion production have been generally seasonal in nature. These crops are usually planted after rice. Garlic and shallot production have been limited to Srisaket in the Northeastern Region and Chiangmai in the Northern Province, whereas onions are grown

Table 4. The production, farm value and export value of vegetables, 1981-86.

Year	Production (t million)	Farm value[z] (US$ million)	Export value (US$ million)
1981	2.22	183.44	12.55
1982	2.00	308.88	20.27
1983	2.03	402.93	26.70
1984	2.13	254.56	28.78
1985	2.00	361.60	38.13
1986	2.12	n.a.[y]	n.a.
Average	2.08	302.28	25.29

[z]US$1.00 = 25 baht [y]n.a. = not available Source: Anonymous 1981-86 and Anonymous 1986a.

Table 5. Area planted to selected vegetable crops, 1981-86.

Crops	1981	1982	1983	1984	1985	1986
	('000 ha)					
Chili	34.2	37.3	33.1	23.7	25.2	18.0
Bird pepper	48.4	42.0	41.7	39.5	42.7	40.5
Ginger	3.7	4.1	6.5	7.2	8.0	4.9
Garlic	41.5	30.5	32.7	40.1	35.6	30.4
Shallot	24.1	19.7	33.5	23.3	16.7	16.9
Chinese radish	7.6	7.2	6.4	7.7	6.0	5.4
Tomato	10.1	9.4	8.2	8.7	8.0	8.3
Garden pea	2.2	2.4	1.9	2.1	2.1	1.3
Cabbage	10.1	11.3	9.8	10.9	11.1	9.9
Cucumber (long)	13.6	14.0	12.4	9.3	10.0	10.3
Yard-long bean	21.5	25.3	22.8	20.5	19.0	20.1
Cucumber (short)	19.9	23.0	18.0	18.0	17.2	16.2
Luffa	5.5	7.1	5.6	6.0	6.0	5.5
Bitter gourd	2.7	3.3	2.5	3.0	3.0	2.5
Chinese cabbage	9.3	9.4	10.6	8.7	8.5	8.0
Lettuce	2.0	2.4	2.8	2.4	2.6	1.8
Leaf mustard	10.4	10.4	9.6	8.9	9.9	9.2
Pakchoi	7.2	9.3	10.2	10.1	8.9	8.8
Chinese kale	10.7	10.8	10.8	11.2	10.4	10.0
Water convolvulus	10.9	13.5	13.1	13.6	12.9	12.3
Yam bean	4.4	6.3	5.7	–	–	–
Pumpkin	13.0	14.2	13.5	13.3	11.0	10.2
White gourd	8.0	7.7	8.1	7.6	7.5	6.0
Taro	6.6	7.7	6.6	5.5	7.3	5.2
Baby corn	–	–	–	7.1	6.4	7.1
Onion	–	–	–	0.5	2.1	1.6
Multiplier onion	–	–	–	4.8	7.2	6.0

Source: Anonymous 1981-86.

in Chiangmai and in Kanchanaburi in the Western Province. Among the above-mentioned bulb crops, garlic holds a high potential for development as a processing product, i.e. garlic capsules, garlic tablets, etc.

Cucumbers, bitter gourd, luffa, white gourd and pumpkin are widely cultivated in almost all provinces of the country. Watermelon production is undertaken as a crop after rice in the central plain and in the Northeastern Region. Cantaloupe is commonly grown in the north.

Yard-long bean is extensively grown year round throughout the country; however, the Central and the Southern Regions have long been known as famous growing areas. Edible sugar pea production is limited to the cool season in the Northern Province.

Among the root crops, taro, sweet potato and ginger are generally cultivated in the Central Region of the country. White or Irish potato production is limited to the cool season lowlands and highlands in Chiangmai.

Leafy vegetables (Chinese kale, Chinese cabbage, Chinese mustards, leaf mustard, Chinese radish, cabbages, etc.) are cultivated year round in the central plain. Today, cabbage hybrids can be planted year round throughout the country. However, they are largely grown during the cool season in the north.

In the future the expanding planted area is expected to be concentrated on export crops which obtain attractive prices. These crops may be baby corn, asparagus, bamboo shoots, mushrooms, cantaloupe, watermelon, tomato, okra and spice vegetables. The export of fresh vegetables to neighboring countries is also important and amounted to 24,788 t worth US$6.784 million in 1986 (Table 6). Future prospects in vegetable growing rely on the expansion of more vegetables which are used as raw materials such as bamboo shoots and ginger. This trend might encourage growers to expand the area of vegetable cultivation.

Table 6. Export value of selected fresh vegetables, 1983-87.

Vegetable	1983		1984		1985		1986		1987[y]	
	Quantity (t)	Value[z] ('000 US$)	Quantity (t)	Value ('000 US$)	Quantity (t)	Value ('000 US$)	Quantity (t)	Value ('000 US$)	Quantity (t)	Value ('000 US$)
Shallot, Garlic	1,946	410	6,144	1,270	7,715	1,560	7,872	1,770	6,217	1,250
Bamboo shoot	231	90	289	200	339	1,410	761	500	225	110
Tomato	173	70	1,360	320	2,123	1,980	3,270	640	5,731	910
Mushroom	14	10	9	10	17	10	19	30	10	10
Potato	3	1	190	50	14	4	210	40	317	50
Others	13,499	3,440	16,674	4,010	17,103	4,310	12,656	3,800	10,110	3,120
Total	15,866	4,021	24,666	5,860	27,311	9,274	24,788	6,780	22,610	5,450

[z]US$1.00 = 25 baht. [y]Preliminary data. Source: Anonymous 1987.

Vegetable Policy of Government

Research and Technology

The principal agency that works on applied and adaptive research is the Ministry of Agriculture, whereas the colleges of agriculture under the universities play a great role in basic research and technology development, as well as some applied research. However, all research activities on vegetable crops are subject to the following policies.

Vegetables are classified into four groups according to their economic significance: (1) vegetables for export (e.g. baby corn, asparagus, yard-long bean and sweet pepper); (2) vegetables

for processing (e.g. tomato, chili, ginger and leaf mustard); (3) vegetables for the local market (e.g. chili, garlic, onion and shallot); and (4) vegetables with future potential (e.g. mushrooms and bamboo shoots).

The research policy is directed towards the following areas:

- To develop varieties according to market preference, with insect and disease resistance, with good keeping quality and with postharvest tolerance to transport and handling;
- To search for seed production technologies in order to become self-sufficient and be able to export to neighboring countries;
- To search for appropriate postharvest technologies, particularly on harvesting, packaging, handling, transportation and standardization;
- To search for appropriate methods of insect-pest control; and
- To develop various techniques in processing vegetables for export and local markets.

Overall Harnessing of Horticultural Resources

In the sixth National Social and Economic Development Plan (1987-91), the government has allocated US$72 million to be spent over the next half-decade to coordinate production and marketing systems with particular emphasis on 200 new agricultural products with market demand. This endeavor will involve the cooperation of both the private and public sectors in setting up a national marketing plan. Among the agricultural crops, vegetables will certainly play a prominent role in this scheme as fresh produce for processing and as a major new export item. Under the above guidelines, the government will have to boost the efficiency in making use of natural resources by diversifying from production of major crops (i.e. rice, maize, cassava, etc.) to the production of crops with a higher value such as vegetables.

Encouragement of Vegetables for Exports

This policy is visible by the involvement of several government agencies in the promotion of high-quality vegetables. The Ministry of Agriculture, the Ministry of Science, Technology and Energy, as well as the colleges of agriculture under the Office of University Bureau, direct their research towards the development of production technology with the aim of helping farmers to produce export-quality vegetables and higher yields with low investments. Many provincial officers also encourage growers to produce better quality crops by organizing vegetable exhibitions and vegetable contests from time to time.

The Commercial Relation Department, the Tourism Authority of Thailand and the Ministry of Science, Technology and Energy also play a part in devising appropriate packaging and organizing vegetable exhibitions in foreign countries. Encouragement of Horticultural Industry, Including Vegetables.

The Board of Investment (BOI) has played a significant role in the promotion of vegetables. In 1986, 55 fruit and vegetable farming and processing ventures have received promotional privileges from the BOI (Anonymous 1986b). Of these ventures 10 have not succeeded, 25 are currently in operation and 20 will begin operation in the future. They are classified as follows.

Large-scale cultivation. Seven enterprises, three of which are already operating on 15,816 ha of land, produce asparagus, pineapple, grapes and tomatoes for canneries. The C.P. company plans to inaugurate an integrated project this year, organizing cultivation, processing and exporting to Japan, Eastern and Western European and Middle Eastern countries. Other companies are examining the possibilities of producing juice from passion fruit, guava and mango and canning asparagus, bamboo shoots and baby corn.

Freezing. Two enterprises have received promotional privileges, one of which is in operation, in processing asparagus, broccoli, cauliflower, baby corn, peas and betal. The production capacity is 187,971 t per year.

Canning. Fourteen canneries have applied for the privileges and 12 are already in operation. Their products include canned baby corn, asparagus, peas, mushrooms and water chestnuts, as well as some fruits. Their capacity is 22 million crates annually.

Juices. Ten firms have applied for privileges in the juice and concentrate field, five of which are now operational and are producing tomato juice, soya bean milk, as well as juice from fruits such as mandarin orange, guava, pineapple, tamarind and passion fruit. Their capacity is 64 million cases annually.

Sauces. Thai sauces are becoming popular in Europe and America as firms in Thailand meet the required hygienic standards. The chief ingredients include: soybean, tomato, garlic, pepper and other spices.

Dried vegetables. Thailand's dried ginger, onion and cucumber have proven very popular in Japan due to their low production cost. The two promoted firms in operation produce a total of 13,500 t annually, and one of them aims at achieving an export value of US$3.6 million in 1988.

Garlic capsules. Thailand produces a large surplus of garlic which is in high demand abroad as a health food. If modern plants to process garlic into tablet and capsule forms were established, then export markets are assured due to the low cost of the raw material.

Future Trends

The expansion of international trade and transport, together with technological advances in food processing techniques, have created markets of great potential for fruits and vegetables from Thailand.

If imaginative entrepreneurs, with government cooperation, can overcome climatic restraints to increase and regularize production of raw materials, and if advanced management techniques are employed to regulate their prices, then the export of processed fruits and vegetables may help to alleviate the problems being experienced in the much bigger but troubled rice trade.

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Research on Vegetables in Thailand

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Introduction

Thailand produces a large number of vegetables, including several indigenous leafy species. Vegetables are not only utilized in the human diet but also produced for export as both fresh and processed products, e.g. canned, dehydrated, frozen, etc. The area planted to 27 types of vegetables in 1987 was 279,040 ha (DOAE 1982) (see Table 5 in Subhadiabandhu and Pileuk in these Proceedings). The country's production of vegetables increased from 1.3 million t in 1961 to 3.1 million t in 1986 (FAO-RAPA 1987). However, vegetable production in the country still suffers from many constraints. For this reason many research projects need to be undertaken in order to generate the mature technologies which can be disseminated to the farmers.

Current National Vegetable Research Program

Currently, research on vegetables in the country is being conducted by government institutions such as the Department of Agriculture, the universities such as Kasetsart, Khonkaen, Chiangmai, Sonkhla Nakkarin and other smaller scale research is being carried out by agricultural colleges and institutes. The research concentrates mainly on varietal improvement, production management, pest and disease control, postharvest development, processing and tissue culture.

Cooperative research among the institutes in the country is organized under the Subcommittee on Vegetable Research and Development Coordination (SVRDC). The Subcommittee consists of the representatives from the universities and many departments in the Ministry of Agriculture and Cooperatives. The National Research Council serves as the coodinating agency. Research on vegetables under SVRDC is divided into four working groups as follows: tomatoes, legumes, crucifers and the corn industry.

Vegetable research under the Department of Agriculture concentrates on the following vegetable: asparagus, chili, crucifers (Chinese cabbage, Chinese kale, Chinese radish, leaf mustard), cucurbits (bitter gourd, cucumber, pumpkin), garlic, ginger, indigenous vegetables, mushroom, onion, potato, shallot, sugar pea, sweet potato, tomatoes, water convolvulus and yard-long bean (DOA 1987).

Areas of Research

The following areas of research are currently being conducted:

- Evaluation and screening of vegetable germplasm for production, quality, resistance to diseases and insects and environmental conditions;
- Varietal improvement by means of selection and breeding for new varieties;
- Improved cultural practices for productivity, e.g. fertilizer, water management, weed control;
- Control of diseases and pests by using appropriate technology in plant protection, e.g. biological control, cultural control, minimize the application of pesticides, etc.;
- Development of appropriate and low-cost postharvest technology;
- Development of simple processing technology for vegetables; and
- Standardization of vegetable seed production technology.

Important Vegetables in the Country

Under the Sixth National Social and Economic Development Plan (1988-91), the Department of Agriculture and Department of Agricultural Extension established a vegetable crops research and development program (DOA and DOAE 1987). The program emphasizes three major groups of vegetables, according to their economic importance, as follows:

Economic vegetables for domestic use. The commodities are chili, shallot, garlic, onion and some leafy vegetables, mainly crucifers.

Industrial vegetables. These are tomatoes, potatoes, sweet potatoes, baby corn, asparagus, leaf mustard and ginger.

Export commodities. The vegetables belonging to this group are yard-long bean, mushrooms and green asparagus.

Research is implemented by the Department of Agriculture in order to generate appropriate technologies and the Department of Agricultural Extension is responsible for transferring the technologies to the farmers by means of on-farm trials, and establishing pilot projects in the communities.

Importance of AVRDC Principal Vegetables in the Country

Many tomato cultivars developed by AVRDC have been evaluated under different conditions in Thailand, some cultivars showed promise and are being used in the breeding programs of some institutes. At present Kasetsart University has developed mungbean varieties, Kamphaengsaen 1 and Kamphaengsaen 2, which originated from VC 1973A and VC 2778A developed by AVRDC. Chai Nat 60 (AVRDC VC 1178) was released to commemorate the king's 60th birthday in 1987.

Other AVRDC vegetables such as Chinese cabbage, soybean and sweet potato have also been tested at the Horticulture Research Institute, DOA and at Kasetsart University and some of the test cultivars exhibited good results (Table 1).

Table 1. Vegetable research under Kasetsart University-AVRDC program (1986-88).

Vegetable	Number of research projects		
	1986	1987	1988
Mungbean	1	3	2
Soybean	2	1	2
Tomato	3.5	7	4
Chinese cabbage	12	2	1
Sweet potato	1	1	1
Others (Asparagus, Cucumber, Chili, Sweet corn, Onion, Yard-long bean)	3	7	22
Total	21.5	21	32

Source: KU 1988.

Constraints to Vegetable Research

Some of the constraints to vegetable research in the country are listed below:

- Inadequate information on the status, problems and marketing of specific vegetables;
- Limited germplasm to develop locally adapted varieties;

- Inadequate manpower and financial support;
- Lack of trained manpower in most disciplines; and
- Insufficient cooperative research among the institutes in the country.

Funding and Manpower Needs for Vegetable Research

More funds are needed to support in strengthening vegetable research and development programs as well as trained manpower in almost every research discipline.

Priorities for Vegetable Research in the Future

The priorities for vegetable research in the future are as follows:

- Postharvest physiology research and development of postharvest technology;
- Breeding for productivity, quality and resistance to diseases and environmental stresses;
- Improvement in production technology;
- Establish appropriate technology to control pests and diseases;
- Establish appropriate vegetable seed production technology;
- Tissue culture technology to produce clean planting materials; and
- Socioeconomic study to provide better information for research and development of vegetables.

Training Needs

Training requires to be undertaken in the following disciplines: breeding, postharvest technology, plant protection, seed production technology, tissue culture and crop management.

Research Collaboration Desired

The collaboraton desired for research in tomato, Chinese cabbage, chili, asparagus and sweet potato is provided in Table 2.

Table 2. Research collaboration desired.

Crop	Research areas
Tomato	Breeding for resistance to diseases, postharvest and seed production technology
Chinese cabbage	Germplasm evaluation for heat tolerance, seed production technology and plant protection
Chili	Germplasm evaluation, postharvest, seed technology and plant protection
Asparagus	Production management, postharvest and tissue culture
Sweet potato	Germplasm evaluation

Perception of AVRDC's Future Role in Vegetable Research

AVRDC should establish a cooperative research network among the Southeast Asian countries. It should provide vegetable germplasm and improved cultivars for evaluation to the

national programs. It should facilitate dissemination of research information and experiences. AVRDC can also provide training for research personnel in the required fields, e.g. breeding, crop management, postharvest technology, seed production, plant protection, tissue culture, etc.

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Discussion: Current Status — Thailand

P.A. Batugal: Could you tell us what the Thai government actually did in terms of policy intervention which helped the vegetable industry?
S. Subhadrabandhu: The government and private sectors together played the role of helping in research and development of vegetables in Thailand.

B. Sikkhamondhol: (1) Today presents a good opportunity for opened-minded discussion about the past experiences and some constraints that can bring to the further discussion for a new proposal project of collaboration vegetable research in Southeast Asia. (2) Thailand's policy of seed production strongly relies on the private sector for seed production programs. The government meets only 5% of the seed requirements of the farmers, 90% to 95% is met by the private sector.

P.A. Batugal: Could you explain further what specific steps the Thai Government took to promote fresh vegetables and processed products for export?
S. Subhadrabandhu: The steps undertaken by the Thai Government are in two directions, through financially supporting research and also through the special policy developed to encourage the private sector to invest in adaptive research/production as well as on marketing of fresh and processed vegetables.

C.Y. Yang: All of the required information which the Thai scientists need from AVRDC has been met as reflected on the information given by the speaker. Germplasm requests have been met. Thailand has its share of germplasm from AVRDC every year. These lines are being used by individual researchers in their breeding work. A good example are the release of new tomato lines (with AVRDC materials as parents) and mungbean lines in Thailand, i.e. Seedathip 1 and 2 for 1988 and Chainat 60 in 1987, respectively. TOP has been responsible for sending 41 Thai researchers to AVRDC from 1982-84 and has worked hard to search for funds for trainees for the Thailand Regional Training Program each year.

C.L. Luh: Dr. Charles Yang at TOP would be an ideal spot to participate in Thailand vegetable research and development program. The training program should be conducted at AVRDC headquarters. Regional testing should be carried out by the national program with assistance from TOP. Germplasm supply or exchange should be of mutual benefit. The distribution of information on research through periodicals suggested by Dr. Batugal is workable. Funds, a coordinator and network are, therefore, needed. Dr. P.A. Batugal's recommendation receives my full support. The proposal that exchange of ideas through meetings like this should be conducted once every two years sounds very good. The Asian Development Bank (ADB) is asked to support and meetings can be rotated among member countries in order to obtain more understanding through frequent contact and visits.

B. Sikkhamondhol: Thailand has passed a regulation on banning some insecticides, e.g. chlorinated hydrocarbon. Also any company that wants to import insecticides has to apply for the permit. The Ministry of Agriculture and Cooperatives makes a good check on the toxicity and residual effects of the compounds.

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Vegetable Research in Southeast Asia — An Overview

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Introduction

Vegetables are the major source of vitamins and minerals in the Asian diet. In 1983 the per caput supply of vegetables varied from 35 to 123 g per day in this region (FAO 1984). There are between 60 and 100 crops consumed as vegetables in various diets, and vegetables also serve as important cash crops for Asian farmers. Although vegetables are receiving increasing attention from the national governments and scientific communities, information on the research environment, support, major interests, and constraints is still lacking.

In order to augment the country reports presented in this Workshop, a survey of Vegetable Research Scientists in Southeast Asia was conducted. Two hundred copies of a questionnaire were sent to the team leaders of each country for distribution. A total of 201 completed forms were received for analysis. A total of 44, 51, 79 and 27 completed forms were received from Indonesia, Malaysia, the Philippines and Thailand, respectively.

In addition to the general background of the scientists, the fields covered in the questionnaire are planning and organization of research, research support, research budget, time allocation, information and communication, and interaction between the scientists and AVRDC. An analysis of the general background of scientists who responded indicated that most of them are associated with either governmental agricultural research institutes or universities (Table 1). There are few respondents from private or other organizations. Although the scientists who responded to this survey constitute only a part of the available human resources in each country, we feel that with the help of country team members the survey has covered most of the institutes actively involved in vegetable research.

All respondents hold at least a BS degree, and the ratios of respondents with PhD degrees are 37%, 38%, 25% and 20% in Indonesia, Malaysia, the Philippines and Thailand, respectively. The average number of years which respondents have been conducting vegetable research is 8.8.

The distribution of vegetable research scientists by disciplines differs only slightly among the four countries (Table 2). There are more agronomists, horticulturists, plant pathologists and breeders than other disciplines.The opportunity to receive special training in vegetable research was surveyed. A total of 94 respondents obtained special training in vegetable research from 52 institutes. Among them, the Asian Vegetable Research and Development Center (AVRDC) and The University of the Philippines, Los Baños (UPLB) are the two most popular institutes in the region. The number of scientists who attended special training in these two institutes is 46 and 13, respectively. It is interesting to note that there are 65 female vegetable researchers who responded to this survey and they constitute 32% of the total number of responding scientists.

Planning and Organization of Research

The activities performed in research institutes are summarized in Table 3. Only governmental institutes and universities are included for analysis. Compared with the number of institutes

Table 1. Classification of vegetable research scientists by institution.

	Indonesia		Malaysia		Philippines		Thailand	
	No. of inst.	No of scientist	No. of inst.	No. of scientist	No. of inst.	No. of scientist	No. of inst.	No. of scientist
Government research inst.	13	25	10	33	17	26	6	19
Universities	9	16	8	13	18	45	2	8
Other	3	3	6	5	6	8	–	–
Total	25	44	24	51	41	79	8	27

Table 2. The distribution of vegetable research scientists by discipline.

Discipline	Indonesia	Malaysia	Philippines	Thailand	Total
Agricultural education a: d extension	2	0	3	0	5
Agronomy	13	10	18	5	46
Entomology	7	5	6	2	20
Horticulture	2	7	16	5	30
Plant breeding and genetics	5	10	9	2	26
Plant pathology	7	3	10	8	28
Plant physiology	1	4	2	0	7
Soil science	2	2	6	1	11
Others	2	4	6	2	14

Table 3. Activities performed in vegetable research institutes.

Activity	Indonesia		Malaysia		Philippines		Thailand		Total
	R[z]	U[z]	R	U	R	U	R	U	
Basic	6	6	3	6	11	13	11	6	62
Production oriented	12	9	6	7	17	18	16	8	93
Training	8	6	4	5	15	15	8	4	65
Extension	4	5	7	2	15	17	1	6	57
Other	0	1	0	0	0	1	0	1	3

[z]R = research institute; U = university.

which responded, as listed in Table 1, it is evident that most of the institutes perform more than two activities. There is not much difference in research activities between universities and governmental research institutes. They both place more emphasize on production-oriented research programs. It is also interesting to note that most governmental research institutes also provide training opportunities, and that the universities in the Philippines are heavily involved in extension work.

Owing to the design of the questionnaire, many respondents did not list the commodities of the institute according to a priority scale. Therefore, the information gathered on this item is simply a comparison based on the frequency of the commodity mentioned by the respondents. A total of 40 vegetables are under active research programs in the region. However, only the top 15 commodities are listed in Table 4.

The specific interests of individual scientists are investigated in the survey. Table 5 shows the main constraints or problems of selected crops which they try to overcome.The problems reported can be classified into 10 groups. Diseases receive the most concern of all problems in all of the countries; this was expected to be one of the most important constraints limiting

Table 4. Vegetables which have active programs in Southeast Asia.

Vegetable	No. of institutes	No. of respondents
Tomato	72	93
Mungbean	44	42
Common cabbage	43	48
Peppers	42	61
Soybean	41	41
Sweet potato	37	32
Potato	33	41
Legumes	29	28
Eggplant	27	21
Common bean	26	23
Onions	26	22
Cucumber	24	23
Yard-long bean	22	20
Chinese cabbage	16	17
Crucifers	15	21

Table 5. Constraints of 15 popular vegetables in Southeast Asia.

Crop	Constraint (no. of respondents)									
	Disease	Pest	Weed	Seed	Moisture	Temperature	Soil	Post-harvest	Low yield	Unclassified
Tomato	69	10	2	9	17	3	9	5	23	21
Mungbean	25	12	-	2	10	-	12	3	8	8
Common cabbage	15	17	2	4	9	1	3	2	15	16
Peppers	39	5	1	6	14	1	9	4	16	26
Soybean	24	12	-	8	9	-	9	2	8	8
Sweet potato	23	13	1	2	7	-	3	3	8	6
Potato	32	7	1	8	2	2	2	1	14	10
Legumes	11	5	1	3	5	-	2	3	11	9
Eggplant	8	10	-	2	3	-	2	1	7	4
Common bean	8	6	1	5	4	1	2	-	3	4
Onions	6	1	-	4	4	-	-	1	8	3
Cucumber	9	2	1	4	4	-	1	2	7	9
Yard-long bean	8	3	1	5	1	-	-	-	5	4
Chinese cabbage	10	3	-	3	4	3	-	2	4	1
Crucifers	18	6	-	1	1	-	-	1	1	2

vegetable production in humid tropical Asia. Various approaches are undertaken to resolve these constraints. The types of approaches used are listed in Table 6. Breeding is the most popular approach to relieve various constraints.

As far as research planning is concerned most scientists are involved in more than two functions. About 80% of the respondents indicated that they are involved in planning experiments for their own discipline and in conducting experiments by themselves. Only 50% of the scientists responding are involved in the development of overall research plans and/or joint research plans with other departments. A further breakdown of planning responsibility by education revealed that the level of education did not affect the scientists' responsibility in the level of research planning significantly (Table 7).

Facilities and Support for Research

The type of facilities used by vegetable research scientists are summarized in Table 8. Statistics of manpower support for vegetable research by country are presented in Table 9. The

Table 6. Research approaches undertaken by vegetable scientists in Southeast Asia.

Approach	No. of respondents	No. of crops
Breeding	491	44
Disease control	142	31
Pest control	96	27
Weed control	1	1
Fertilization	104	27
Water management	59	27
Cropping system	41	26
Cultural management	196	34
Physiological responses	2	2
Storage and postharvest	56	23
Hydroponic	4	4
Unclassified	123	33

Table 7. Responsibility of research planning by education.[z]

Responsibility	PhD	MS (Ir.)	BS
Overall research planning of institute	25	33	13
Joint project with other departments	36	43	19
Planning of own discipline	52	61	35
Experiment implementation	50	69	42

[z]Total number of respondents is 188.

Table 8. Research facilities used by discipline.

Discipline	No. of respondents	Field	Laboratory	Greenhouse
Agricultural education and extension	9	4	3	2
Agronomy	88	45	23	20
Entomology	45	19	17	9
Horticulture	49	26	9	15
Plant breeding and genetics	61	25	18	20
Plant pathology	47	18	24	21
Plant physiology	15	5	5	5
Soil science	19	11	4	40
Others	24	11	7	6

Table 9. Support of technical staff and field laborers for vegetable research scientists.

Education level of supporting staff	Mean of all respondents	Indonesia	Malaysia	Philippines	Thailand
PhD	0.5	0.5	0.8	0.4	0.6
MS (Ir.)	2.7	3.9	3.1	2.3	0.6
BS	4.8	2.3	1.8	8.9	1.9
Diploma	1.7	2.1	2.6	0.9	1.6
Field laborer (manday/month)	110.4	205.0	132.8	63.3	59.1

average number of technical staff under the supervision of respondents is 10, and the average number of field laborers to support their work is 110 mandays per month. The supporting staff for respondents with PhD degrees is further analyzed, and they have much more field laborers (190 mandays per month) to help. The survey requested vegetable research scientists to rate the adequacy of the resources available for conducting vegetable research. A scale of 1 to 10

in which 1 = inadequate and 10 = adequate, is used to rate different resources. The results by country are summarized in Table 10. Generally, the rate of adequacy for most resources is higher than 5. Fertilizers received the highest score among the resources listed. However, large variation was observed in the rating of every resource, even within the same country.

Additional training of various types was listed in the survey form and scientists were requested to rank them in priority of their usefulness. The responses are summarized in Table 11. Fundamental and long-term training were ranked as the most favorable training by respondents in all countries.

Table 10. Adequacy of resources available for vegetable research.

Resource	Overall rating[1]	Indonesia	Malaysia	Philippines	Thailand
Planting material	6.47	5.92	7.44	6.23	6.32
Seed	6.49	6.51	6.96	6.07	6.73
Fertilizer	8.19	8.62	9.23	7.38	7.86
Pesticides	7.88	8.13	8.81	7.26	7.48
Irrigation	5.39	6.03	5.70	4.66	5.91
Manpower	6.25	7.74	6.00	5.82	5.64
Equipment	5.85	5.49	7.23	5.16	5.88
Greenhouse	5.59	7.03	6.23	5.03	3.74
Laboratory supplies	5.62	4.72	7.23	5.42	5.00

[1]Rating: 1 = inadequate 10 = adequate

Table 11. Priority of training ranked by Southeast Asian vegetable research scientists.[1]

Type of training	Average rank overall	Indonesia	Malaysia	Philippines	Thailand
Fundamental	2.25	2.59	3.18	2.78	3.00
Short term	1.99	2.19	2.24	2.11	1.58
Relative long term	2.39	3.07	3.00	2.62	2.21
Visit and exposure	2.03	2.15	1.94	2.26	1.88

[1]4 = the highest priority

Research Budget

It is a difficult task to investigate the available budget for vegetable research. Especially for scientists who are not working exclusively on vegetables. A total of 94 scientists responded to this item. The mean budget of each scientist for vegetable research in this region is about US$11,000 per year; and 40% of the respondents indicated that their budgets are entirely supported by the institution. About 28% of the respondents are able to obtain financial support from the private sector or international organization.

Time Allocation

Most scientists (84%) responded that they have other responsibilities in addition to vegetable research. On the average, they spend 44% of their time on research. Table 12 shows the portion of time allocated to vegetable research with level of education. A clear trend can be observed: the higher the educational level, the less time is spent on research. A further breakdown on time allocation shows that 60% of the scientists are involved in training and 54% in extension. Even scientists working in the research institutes spend 10% of their time in training and 9% with farmers.

Information and Communication

Information and communication is an important support for research scientists. The first objective of this survey is aimed at gathering the general information on opportunities for vegetable research scientists to communicate with scientists in the same field and other related fields. In addition the library facilities are also included in order to understand the situation. Thus, actions might be taken to strengthen the information sharing within the region, as well as the services from international centers.

The opportunity for communication is arbitrary divided into three levels — two or more times a year; at least once a year; and less than once a year — for professional meetings, seminars, etc. The responses are summarized in Tables 13 and 14. Analysis of communication opportunity

Table 12. Time allocation (%) for vegetable research.

Education	Mean	Indonesia	Malaysia	Philippines	Thailand
			(% of time)		
PhD	36.5	47.7 (11)[z]	31.0 (15)	31.1 (19)	49.0 (5)
MS (Ir.)	44.6	44.2 (20)	36.2 (14)	45.2 (24)	58.8 (8)
BS	54.0	–	44.4 (9)	59.4 (17)	51.7 (6)

[z]Numbers in parenthesis indicate the number of respondents.

Table 13. The communication opportunity of vegetable research scientists in their own field.

Contact type	Number of respondent					
	National			International		
	A[z]	B	C	A	B	C
Indonesia						
Professional meetings	10	15	6	0	3	18
Research planning workshops	11	14	6	0	5	17
Seminars	20	9	3	0	5	19
Short-term training courses	2	8	15	0	1	21
Malaysia						
Professional meetings	17	17	9	1	7	31
Research planning workshops	4	14	21	0	2	30
Seminars	11	15	18	2	5	30
Short-term training courses	0	1	35	0	0	33
Philippines						
Professional meetings	18	49	5	2	6	30
Research planning workshops	27	36	8	0	7	30
Seminars	43	24	6	2	6	26
Short-term training courses	12	12	28	2	1	24
Thailand						
Professional meetings	14	7	5	1	3	12
Research planning workshops	9	9	8	1	0	14
Seminars	14	9	3	1	0	13
Short-term training courses	3	3	14	0	0	15

[z]Frequency: A = two or more times per year; B = at least once a year; and C = less than once a year.

Table 14. The communication opportunity of vegetable scientists with scientists in other fields.

Contact type	Number of respondent					
	National			International		
	A[z]	B	C	A	B	C
Indonesia						
Professional meetings	5	10	13	0	3	16
Research planning workshops	7	9	12	0	4	15
Seminars	9	13	9	0	2	18
Short-term training courses	0	8	16	0	0	17
Malaysia						
Professional meetings	14	17	13	2	5	29
Research planning workshops	4	10	25	0	3	29
Seminars	8	16	17	1	7	28
Short-term training courses	1	3	32	0	0	31
Philippines						
Professional meetings	14	29	20	1	6	23
Research planning workshops	19	31	14	0	5	23
Seminars	27	27	18	5	3	23
Short-term training courses	10	12	25	3	1	18
Thailand						
Professional meetings	7	9	5	0	2	13
Research planning workshops	4	8	11	0	2	11
Seminars	9	10	3	0	1	12
Short-term training courses	0	4	15	0	0	13

[z]Frequency: A = two or more times per year; B = at least once a year; and C = less than once a year.

by country revealed that scientists in the Philippines have more opportunities for communication, both in national and international activities. The percentage of scientists who indicated that at least one type of contact was conducted two or more times per year is 74%, 66%, 77% and 70% for Indonesia, Malaysia, the Philippines and Thailand, respectively.

About 84% of the respondents reported that they have immediate access to library facilities. Respondents who reported negatively are mostly associated with private organizations. The library holdings for vegetable research, however, are not very satisfactory. The average rating on a 1 to 10 scale in which 10 is the highest rating on library services is generally less than 6 (Table 15). Among the services rated, translation services received the lowest score in this region. However, the requirements are different from country to country.

Respondents were requested to rank the relative importance of information sources in the library. Professional journals, technical bulletins and symposia proceedings received highest recognition on relative importance by respondents in all countries (Table 16). Research scientists are looking for first-hand information sources for their works. However, these types of information sources are also difficult to obtain (Table 17). The type of assistance needed to disseminate the research results was also queried in the survey. Publication opportunity is reported to be the most helpful assistance in this regard (Table 18). Respondents feel that linkage with extension agents and farmer-oriented magazines are the most helpful methods to disseminate their research results to their respective target group. However, a distinctly different response can

be observed between scientists working at a research institute and a university. It is understandable that the primary objectives of these two types of institutes are different.

Table 15. Perceived level of library services for vegetable research.[z]

Function	Overall	Indonesia		Malaysia		Philippines		Thailand	
		R[x]	U[w]	R	U	R	U	R	U
Collection	5.13	5.53	3.64	4.92	7.46	5.39	4.74	4.40	6.60
	(160)[y]	(19)	(14)	(26)	(13)	(23)	(42)	(10)	(5)
Services	3.97	4.22	3.44	4.18	5.59	4.26	3.76	2.13	2.88
Abstracting	4.20	4.81	2.62	4.36	6.08	4.61	3.95	2.50	3.60
	(151)	(16)	(13)	(25)	(12)	(23)	(40)	(10)	(5)
Literature search	4.67	5.33	2.38	5.13	6.58	5.22	4.59	3.20	4.80
	(155)	(18)	(13)	(24)	(13)	(23)	(41)	(10)	(5)
Translation	2.27	2.36	2.00	1.95	2.70	2.44	2.58	1.22	2.40
	(132)	(14)	(12)	(21)	(10)	(18)	(36)	(9)	(5)
Reprint	4.53	4.00	6.92	5.12	6.42	4.38	3.78	1.44	3.60
	(149)	(16)	(12)	(25)	(12)	(21)	(41)	(9)	(5)

[z]Rating on a 1 to 10 scale. 1 = inadequate 10 = adequate. [y]Number of respondents. [x]R = research institute. [w]U = university

Table 16. The relative importance of information sources.

Type of information	Mean ranking	Number of respondents
Professional journals	1.90	185
Technical bulletins	2.49	188
Annual reports	3.35	186
Extension bulletins	4.56	174
Newsletters	4.81	162
Symposia proceedings	3.13	184
Theses	5.56	151
Personal communications	4.93	175
Other sources	5.61	18

Table 17. Information sources important for vegetable research but difficult to obtain.

Information source	Overal mean	Indonesia	Malaysia	Philippines	Thailand
Professional journals	2.46[z]	1.59 (39)[y]	3.18 (40)	2.51 (68)	2.58 (19)
Technical bulletins	2.87	2.82 (38)	2.74 (43)	2.81 (68)	3.56 (18)
Annual reports	3.64	3.53 (40)	3.90 (42)	3.70 (66)	3.14 (22)
Extension bulletins	4.34	4.35 (37)	4.30 (37)	3.98 (63)	5.71 (17)
Newsletters	4.32	4.43 (35)	3.92 (37)	4.25 (63)	5.24 (17)
Symposia proceedings	2.94	2.90 (39)	3.14 (42)	2.96 (68)	2.50 (18)
Theses	4.79	4.71 (28)	4.87 (30)	4.98 (55)	4.00 (14)
Reprints	4.89	4.84 (31)	4.43 (35)	5.19 (52)	5.00 (17)
Others	5.54	4.83 (6)	6.00 (3)	6.25 (4)	–

[z]Values are mean rating on a 1 to 10 scale; 1 = most important; 10 = least important. [y]Numbers in parenthesis indicate the number of respondents.

Table 18. Type of assistance which is helpful to disseminate research results in the scientific community.

Type of assistance	Overall	Number of respondent[z]							
		Indonesia		Malaysia		Philippines		Thailand	
		R[y]	U[x]	R	U	R	U	R	U
Publication opportunity	139	21	14	19	11	18	38	15	3
In-house publication	93	7	5	13	9	15	32	5	7
Statistical service	43	8	2	5	1	8	11	6	2
Editorial service	44	8	4	5	3	8	11	4	1

[z]The total number of respondents is 189. Numbers in the table are results of multiple choice [y]R = research institute.
[x]U = university.

Interaction with AVRDC

A total of 93% of the respondents indicated that they are aware of AVRDC as a source of vegetable germplasm and information. Among all respondents, 64% of them are on the AVRDC mailing list and accessible to AVRDC publications. This is not surprising since the AVRDC mailing list was utilized as a basis for distributions of many of the questionnaires. The AVRDC *Annual Progress Report Summaries* is judged to be the most useful information (Table 19).

Out of the 201 respondents, there are 46 former AVRDC training scholars and they represent 13% of the total number of scholars who have been trained at AVRDC from these countries. It is interesting to find that most of the former scholars have been promoted and the present research subject of 64% of them is related to their project during their training programs at AVRDC. There are 95 respondents who rated the usefulness of the AVRDC training program. The overall average rating, on a scale of 4 is very useful and 1 is not useful, is 3.68. Among the various activities of the training program, contact with scientists and conducting field experiments are considered to be the most useful for their research work.

Seventy-one respondents indicated that they have attended at least one AVRDC-sponsored activity. The total mantime of respondents who attended AVRDC-sponsored activities is 120. The most popular activity was training, with a 45 mantime rating.

Table 19. Usefulness of AVRDC information.

Type of information	Number of respondent[z]				
	Indonesia	Malaysia	Philippines	Thailand	Total
Newsletter	19	37	57	12	125
Annual reports	37	40	66	21	164
Technical bulletins	29	47	63	16	155
Guide sheets	8	16	19	9	52
Symposia proceedings	28	39	58	20	145
Bibliographic service	23	31	36	12	102
Other	1	–	–	–	1

A Survey on Vegetable Research Literature

A survey on vegetable research literature published by scientists in the Southeast Asian region was conducted. The database of Agriasia at the Southeast Asian Regional Center for Agriculture (SEARCA) was utilized to determine the number of publications from this region. A total of 2,381 articles on vegetables, written by scientists from the four Southeast Asian countries, were included in the database. Since the database was initiated in 1975, these articles have all been published during the period from 1975 to 1987.

The number of publications per year was found to be rather steady from 1976 to 1985. Among the publications collected, there are 1,042, 926, 236 and 177 written by scientists from the Philippines, Thailand, Indonesia and Malaysia, respectively. Further analysis revealed that about 42% of these publications are included in the FAO database, Agrindex.

The breakdown of these publications based on the classification of FAO is shown in Table 20. Vegetable research covers a very broad field under the FAO system. It is obvious, however, that production-oriented research received more concern by Asian scientists during this period. A further breakdown of publications on production by subgroups revealed that breeding, diseases and pests are the most popular subjects in all four countries (Table 21).

Table 21 presents the number of scientists reported to be working in their respective fields in our survey. The ratio of these two numbers reflected that scientists in the field of plant physiology seem to publish more than others. The number of publications of the 10 major crops are listed in Table 22. It is interesting to note that there are some crops which received a high degree of concern in all four countries. About 77% of the crop-oriented information available is concentrated on these 10 vegetables.

Table 20. Literature on vegetables from Indonesia, Malaysia, the Philippines and Thailand.

Topic	Number	%
Agriculture, general	7	0.3
Education, extension and information	6	0.3
Agricultural economics, development and rural social	214	9.0
Plant science and production	1,298	54.5
Plant protection	448	18.8
Postharvest technology	54	2.3
Animal science, production and protection	58	2.4
Fisheries and aquaculture	1	0.0
Agricultural machinery and engineering	12	0.5
Natural resources and environment	65	2.7
Processing of agricultural products	195	8.2
Human nutrition	16	0.7
Pollution	3	0.1
Methodology (mathematics and statistics)	4	0.2
Total	2,381	100.0

Table 21. The top ten topics of literature on vegetables and number of respondents in corresponding area.

Topic	No.	%	No. of respondents in corresponding area
Plant science and production	512	21.5	–
Plant genetics and breeding	214	10.1	439
Plant diseases	209	8.8	74
Plant pests	149	6.3	75
Fertilizing	136	5.7	95
Cropping patterns and systems	134	5.6	38
Food processing and preservation	109	4.6	51
Crop husbandry	104	4.4	140
Plant physiology and biochemistry	93	3.9	2
Trade, marketing and distribution	89	3.7	0
Subtotal	1,776	74.6	
Other 68 topics	605	25.4	236
Total	2,381	100.0	1,150

Table 22. Number of publications of the 10 major crops.

Crop	Number of publications				
	Indonesia	Malaysia	Philippines	Thailand	Total
Mungbean	25	19	183	222	449
Cassava	59	27	133	227	446
Vegetables (general)	46	42	168	115	371
Potato	34	4	128	34	200
Tomato	11	12	83	74	180
Sweet potato	6	2	140	12	160
Soybean	10	4	31	58	103
Common cabbage	18	7	38	27	90
Onions	–	6	48	17	71
Garlic	4	1	22	31	58
Total	213	124	974	817	2,128

Discussion

Distribution of Research Resources Among Crops

It has been estimated that there are from 60 to 100 crops used as vegetables in the diet of tropical Asia. This survey revealed that there are active research programs on 55 vegetables at various institutes in this region. A literature survey also shows that at least 63 vegetables have been studied by the scientific community since 1975. However, the survey result also indicates that most of the research resources are concentrated on a few vegetables. More than 76% of the publications are on 10 vegetables and 93% of the available publications are for the top 20 vegetables.

The survey on vegetable research scientists indicated that 132 respondents are working on the 10 most popular crops, namely tomato, peppers, common cabbage, mungbean, soybean, potato, sweet potato, legumes, common bean and eggplant. Among the ten crops, the first five crops have breeding programs for various objectives in all four countries. Compared with the vegetables listed in Table 4, one may find that there are six crops which appeared in both lists. Cassava, soybean, mungbean, corn, potato, sweet potato and legumes are vegetables which are recognized as a calorie and protein source. The important vegetables for vitamins and minerals are tomato, common cabbage, onion, common bean, eggplant, pepper and garlic. Among them there is only one leafy vegetable, common cabbage, which is not a really nutritious dark green leafy. This clearly suggests that the leafy vegetables, especially the tropical vegetables, are neglected by the scientific community in this region.

In order to use the limited resources effectively, two types of research networks seem to be needed; one concentrates on the major vegetables such as breeding efforts on tomato, peppers, cabbage, etc. to improve the research efficiency of ongoing research programs. The resources saved from improvement of efficiency should be shifted to vegetable crops which are important, yet have been neglected in the past. A collaborative test network to determine performances of those vegetables under various tropical environments could be an effective way to distribute accumulated experiences from each country to other corners of the region.

Research Programs from a Production Perspective

A regional workshop on Pre- and Post-harvest Vegetable Technology in Asia was held in Los Banõs, the Philippines in February 1977 (AVRDC 1977). Scientists from nine Asian countries were represented. Constraints and future plans of vegetable research in the respective countries were included in country reports of some countries. It would be interesting to review the progress made during the last 10 years on some aspects of those constraints. The shortage of qualified

research staff for vegetables was mentioned by scientists from Indonesia. It was stated that there was only one PhD staff member in the Indonesia Horticulture Research Institute which had a total of 168 technical staff at that time. Our survey showed that there are 15 PhD and 26 Ir. scientists who responded from this same institute today.

It can be expected that a major objective of any vegetable research program is aimed at improving the vegetable industry of the respective nation. Thus, to review the progress made by the vegetable industry may give us a general idea on the effectiveness of the research programs. Unfortunately, the statistics available on vegetable industry in Southeast Asia are rather limited. Based on FAO statistics, the production volume and harvest area of selected vegetables in 1977 and 1985 of the four countries are shown in Table 23.

Table 23. Vegetables in Southeast Asia, 1977 and 1985.

Crop	Area ('000 ha)		Yield (t/ha)		Production ('000 t)	
	1977	1985	1977	1985	1977	1985
Indonesia						
Soybean	646	900	0.8	0.9	527	825
Onion	49	49	3.7	4.3	340	210
Tomato	62	23	6.4	5.0	395	115
Peppers	–	102	–	2.0	–	205
Eggplant	–	33	–	4.1	–	134
Cabbage	–	28	–	10.9	–	305
Cucumber	–	26	–	6.7	–	170
Bean	–	12	–	3.8	–	47
Carrot	–	7	–	8.0	–	56
Malaysia						
Tomato	6	5	4.9	4.9	29	25
Cucumber	1	1	2.2	2.0	2	2
Gourd	–	–	3.1	3.2	1	1
Cabbage	–	–	–	11.1	–	5
Philippines						
Tomato	20	14	7.5	9.1	150	130
Eggplant	16	17	4.0	6.7	80	114
Soybean	15	–	0.7	–	11	–
Onion	13	6	4.6	6.8	60	77
Cabbage	8	7	6.7	10.6	55	130
Garlic	5	5	3.5	2.8	17	14
Peppers	–	35	–	1.2	–	42
Thailand						
Soybean	102	198	1.0	1.5	98	296
Cabbage	35	18	5.4	5.4	185	94
Garlic	30	44	5.6	4.2	170	182
Onion	26	19	5.8	8.3	150	153
Bean	16	18	2.5	2.4	40	42
Eggplant	11	11	5.3	5.5	56	58
Gourd	9	8	8.1	8.7	70	73
Cucumber	8	7	8.7	10.5	68	71
Tomato	6	7	2.7	4.5	15	33
Cauliflower	4	4	6.6	6.5	23	26

Source: FAO 1978 and 1986.

Improvement of the yield per unit area can be detected for several vegetables in each country. It is a reasonable assumption that a significant part of this progress is due to the impact of research programs in the country. It is interesting to note that improvement made on commodities which received more research attention may not necessarily be greater than those which received less attention. It is also interesting to note that commodities which have better yield improvement have not necessarily increased their production area and/or their total production. This result suggests that, unlike with stable crops, neither the acreage nor the yield are the best parameters to evaluate the impact of vegetable research.

Data of 17 selected vegetables are used for further analysis (DOAE 1987). The percentage changes in yields were plotted against the changes in harvested area between 1981 and 1985 (Figure 1). There are only two crops, soybean and ginger, which show a positive relationship between these two parameters. The harvested area of nine vegetables decreased during this period regardless that improvements in yield were obtained. Market limitation and diversification of vegetable consumption patterns could be the reasons partially contributing to this result. Hence, it could be important for national programs to make a clear policy on the direction of their vegetable industry's development. These more specific parameters could be identified to estimate the impact which has issued from the vegetable research program.

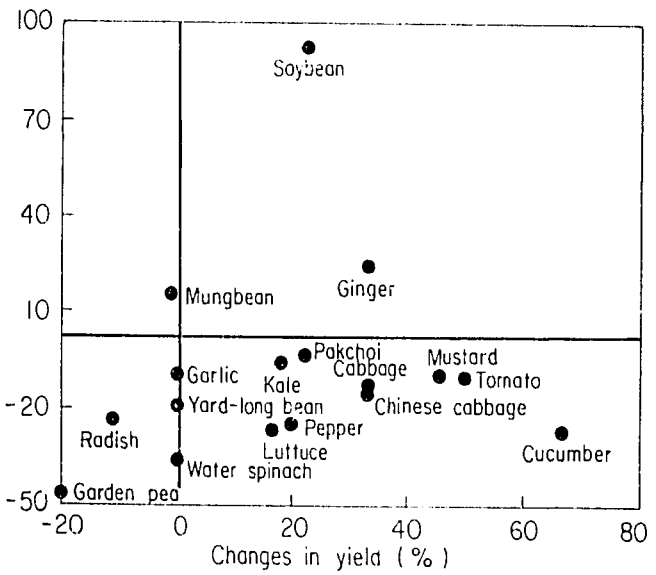

Figure 1.
The relationship of change in harvest area and changes in yield of selected vegetables between 1981 and 1985.

Most respondents indicated that scientific journals are the most important information sources for their research. However, the average rating that this category received in library collections is about 6 on a 1 to 10 scale in which 10 is optimal. It is also clear from the survey results that besides a few specific institutes, most vegetable research scientists are working at small institutes with a few scientists interested in vegetables. Thus, it is not worthwhile to have a complete collection of scientific journals in their libraries.

An effective regional network on information exchange for vegetable research could be an alternative solution. The information network should not only include a computerized information retrieval system but also a hard copy backup. Information available in the network should go beyond the scientific papers published, and extend to documents of experimental results published as research notes and communications with regional interest. The information network should have an active interaction with the research network systems, including activities such as a selective dissemination of information (SDI) service, current vegetable research information services, newsletters to network scientists, preparation of practical publications relating to research

priorities, and collecting and disseminating information by personal computer dises. A successful training program on effective utilization of this system to collect, as well as to disseminate, the information through the network can be a very important factor at the initial stage of the network program.

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Vegetable Research at AVRDC: Achievements and Future Thrusts

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Introduction

We welcome this opportunity to share some of the accomplishments and goals of the AVRDC with such a distinguished gathering. For many of you, who are familiar with Center activities, this brief presentation will be a review. For those of you who may be on your first visit to AVRDC, we hope this briefing will reflect the dedication and concern of our staff in their efforts to serve this very important region. The AVRDC is international in its service and scope; composition of its senior scientific staff; and its funding base. To the members of this Workshop, it will become quite evident that this Center focuses most on the problems of Asia. Approximately 70% of the AVRDC output is devoted to this region (Table 1). The four countries represented at this conference receive approximately 40% of the total output of the AVRDC (Table 2).

The region is very diverse in its climatic, edaphic, social and economic conditions. In some countries emphasis on vegetables may be on national consumption, whereas others may accent export purposes. To serve such a diverse region is challenging and rewarding. Some dimensions of this diversity may be shown in the vegetable production summaries for three of the countries represented at this workshop (Table 3).

Objectives

It is clearly stated in the Charter objectives (AVRDC 1976) that the Center was created to aid in the task of strengthening research and extension programs of the nations served, as shown:

1. To conduct research on production and marketing programs and to assist participating countries in developing their own adaptive research programs.
2. To carry out training in production and marketing programs and to assist participating countries in developing more efficient training and marketing programs.
3. To develop and provide basic information on improved production and marketing for use in extension services in participating countries.

As organizations evolve, needs should guide program direction. This is a major reason why this workshop is so important. Your presentation of the needs in your national programs should help AVRDC to sharpen its focus and help it develop more targeted programs. The functional concerns of AVRDC which have evolved during the past decade are listed:

1. To relieve the production and **income generating** constraints of vegetables in the tropics.
2. To improve **human nutrition** through more effective use and availability of vegetables in the tropics.
3. To **assist national programs** in the development of improved vegetable production and marketing programs.

These functional concerns are harmonious with the Charter objectives, and reflect the growing concern of human nutrition and need to improve incomes in the region served.

Table 1. AVRDC output by region, 1973-88.

Region	Germplasm distributed	Publications distributed	Training participants
		(%)	
Africa	7.3	6.6	2.4
Asia	69.0	55.8	86.9
Oceania	3.0	4.8	2.7
Americas	19.3	25.3	4.7
Europe	1.4	7.5	3.3
Total	100.0	100.0	100.0

Table 2. AVRDC outputs in Indonesia, Malaysia, the Philippines and Thailand.

Factor	Indonesia	Malaysia	Philippines	Thailand
		(no.)		
Trainees	60	39	174	79
Mailing list	209	192	641	269
Seed packets distributed	14,280	5,506	31,035	25,080

Table 3. Vegetable production in Indonesia, the Philippines and Thailand, 1986.[1]

Rank	Indonesia		Philippines		Thailand	
			('000 t)			
1	Cabbage	4,296	Squash	927	Garlic	353
2	Potato	324	Mustard	315	Pumpkin	150
3	Shallot	274	Bottle gourd	161	Shallot	143
4	Chili	272	Tomato	143	Cucumber	123
5	Beans	264	Chayote	90	Cabbage	106
6	Cucumber	233	Eggplant	99	Ginger	92
7	Tomato	148	Cabbage	74	Chinese kale	84
8	Chinese cabbage	133	Bitter gourd	66	White gourd	79
9	Eggplant	131	Bunch onion	54	Bird pepper	75
10	Bunch onion	91	Potato	51	Chinese cabbage	64

Source: National statistical reports, 1986 [1]Excluding sweet potato and food legumes.

Structure and Staffing Pattern

The primary functions of the AVRDC are to serve as a germplasm, information and training center. To perform these roles, the current staffing pattern has been developed (Table 4). In its early period of development, the Center was structured into departments; however, it has since evolved into a program-oriented, multidisciplinary approach. Table 5 reflects the changes to the present. In the current program structure, the array of disciplines within each program is illustrated in the AVRDC organizational chart (Figure 1).

AVRDC Roles

Vegetable Germplasm Center

The AVRDC serves as a focal point for the breeding of specific vegetables of greatest value to the hot humid tropics and as a center for the collection and conservation of germplasm.

Table 4. AVRDC staffing patttern, 1988.

Activity	Senior	Technical	Labor	Total
	(no. of staff)			
1. Research Program				
Crop Improvement	7[z]	37	91	135
Production Systems	4	16	31	51
Development	2	2	6	10
2. Research Support	7	39	98	144
3. Administration	4	7	22	33

[z]Has temporary vacant position.

Table 5. Organization changes at AVRDC, 1972-85.

Period		Department or unit	
1972-74	Chemistry Entomology Plant Breeding	Plant Pathology Plant Physiology Soil Sciences	Experimental Farm Library
1976	**Addition**	Agricultural Economics Crop Management	Training Information
1981	**Reorganization**	Horticultural Crops Program Legume Program Nutrition, Environment, Management Program Training, Communication & Research Services	
1985	**Reorganization**	Crop Improvement Program Production Systems Program Development Program Research Support Group	

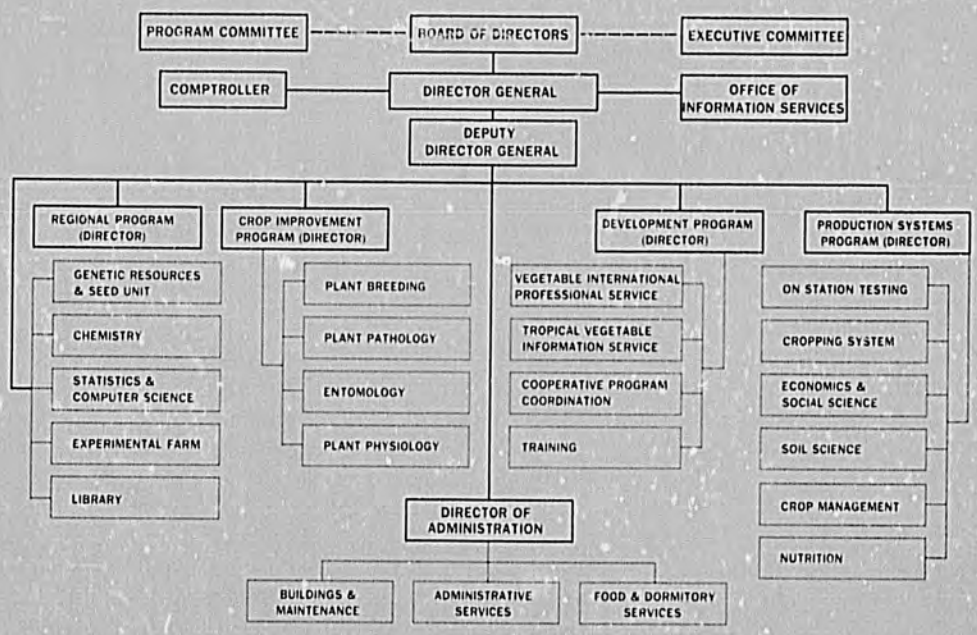

Figure 1. AVRDC organization chart, 1988.

The current list of principal crops which are intensively addressed in the crop improvement program was selected from a large list of vegetables on the following basis:

- popularity in the tropics;
- nutritional level;
- potential for successful production in the hot, wet lowland tropics;
- potential to increase farmer's income;
- adaptability for inclusion into the present farming systems; and
- practicality of inclusion into the existing research environment of AVRDC.

Table 6 reflects the evolution of AVRDC crop selection which was modified by available resources, work load and withdrawal of the Irish potato in 1979.

The AVRDC collects and maintains primitive, commercial hybrid and open-pollinated genetic material, as well as special-purpose mutant and breeding stocks.

The Center is recognized for its germplasm collection and maintenance activities. It is one of the world repositories designated by the IBPGR to hold the mungbean and Asian-Pacific sweet potato collections. Currently, the Genetic Resources and Seed Unit maintains more than 25,000 accessions of vegetables important to the humid tropics.

Of the principal vegetables, the growth in accessions during the past twelve years is indicated in Table 7; whereas the growth in seed distribution during the past decade is provided in Table 8. The marked increase in germplasm distribution is due to an ever-widening awareness of the worth and availability of AVRDC germplasm as parents for breeding programs or for direct testing and national release.

The germplasm distributed to the national programs represented at this Workshop is presented in Table 9.

The germplasm received by the national programs may be utilized in breeding programs or used for direct testing, which may ultimately result in the release of an approved variety. The AVRDC does not release varieties, it only supplies genetic materials to the national programs for their disposition (Table 10).

Information Center

The AVRDC serves as a focal point for the generation, collection and distribution of a wide range of information related to the production of vegetables. A large percentage of the production technology information distributed is AVRDC generated, but its total information base represents publications collected from worldwide sources.

The AVRDC Library acts as an information resource to support the research and training programs at the Center as well as to vegetable specialists in over 100 countries. At present, library holdings consist of 10,420 monograph titles, 1,085 serial titles and more than 23,000 documents on AVRDC principal crops. The computerized information retrieval system contains the main bibliographic, thesaurus, institution and serial holding data bases with on-line searching capability.

The Office of Information Services (OIS) is the multifunctional communication arm of AVRDC charged with editorial, document preparation, distribution, art and photographic services and public relations. At present OIS maintains over 50 titles of AVRDC publications in print for worldwide dissemination. More than 6,000 institutions and individuals in 160 countries receive AVRDC publications each year.

The Center has sponsored a number of international symposia, each of which was designed to generate a state of the art benchmark publication as well as bring scientists together for interchange of ideas and assessment of research priorities (Table 11).

The AVRDC, through the generous support of the Asian Development Bank, initiated activities in cooperative, technical assistance programs in the following countries in Asia; the Republic of Korea (1975), the Philippines (1975), Thailand (1981), Indonesia (1984) and Malaysia (1984).

Table 6. Evolution of AVRDC crop selection, 1971-88.

Date	Period	Vegetables considered		
1971	Planning Council	26 vegetables		
	Preliminary List	Mungbean	Irish potato	Chinese cabbage
		Soybean	Sweet potato	Heading cabbage
		Tomato	Onion	Kangkong
		Eggplant	Chinese radish	Pak choi
1972	Dedication Period			
		Mungbean	Tomato	Irish potato
		Soybean	Chinese cabbage	Sweet potato
1979		Withdrawal of the Irish potato		
1986		Addition of Pepper (hot and sweet)		
1988	Current	Mungbean	Tomato	Chinese cabbage
		Soybean	Peppers	Sweet potato

Table 7. Genetic resources of principal vegetables at AVRDC, 1975-87.

Principal vegetables	1975	1987
Chinese cabbage	601	804
Mungbean	3,560	5,107
Soybean	9,039	11,670
Sweet potato	354	1,187
Tomato	3,799	5,800
Pepper	–	5,100

Table 8. Total cumulative germplasm distribution by AVRDC, 1979 vs. 1987.

Crop	1979	1987
	(no. of seed packets sent)	
Tomato	3,000	48,723
Chinese cabbage	1,200	18,298
Soybean	4,500	98,292
Mungbean	4,400	61,889
Sweet potato[z]	300	5,775

[z]Distributed as vegetative clones, not as seed packets.

Table 9. AVRDC germplasm distribution in Southeast Asia, 1976-87

Crop	Indonesia	Malaysia	Philippines	Thailand
	(no. of seed packets sent)			
Chinese cabbage	557	952	2,865	2,544
Mungbean	4,517	1,075	10,093	9,743
Soybean	8,229	1,417	6,073	9,032
Sweet potato	220	177	1,509	583
Tomato	1,217	1,597	10,132	4,693

Table 10. Germplasm releases by Southeast Asian national programs using AVRDC genetic materials, 1988.

Crop	Indonesia	Malaysia	Philippines	Thailand
	(no.)			
Chinese cabbage	2	–	3	–
Mungbean	4	1	3	3
Soybean	4	1	1	1
Sweet Potato	–	–	2	–
Tomato	4	1	1	4
Total	14	3	10	8

Table 11. International symposia organized by AVRDC, 1977-88.

Title	Date held	Title	Date held
Pre- and Post-Harvest	Feb. 1977	Sweet Potato	March 1981
Soybean Rust	Feb. 1977	Tropical Soybean	Sept. 1983
Mungbean I	Aug. 1977	Diamondback Moth	March 1985
Tropical Tomato	Oct. 1978	Mungbean II	Nov. 1987
Chinese Cabbage	March 1980	Tomato-Pepper	March 1988

The information functions of AVRDC cover six main categories: (a) symposia, (b) workshops, (c) data base generation, (d) consultancy, (e) technology generation and (f) publication preparation and distribution.

As reflected in this Workshop, the national programs look to AVRDC to initiate and implement a wide range of pertinent conferences to supplement the training they receive. The need for workshops of a specialized nature is far greater than the AVRDC resource base can provide; thus, the Center must maintain a continual search for external support for these extremely important activities.

Training Center

AVRDC offers three different kinds of training programs, ranging in length from a few weeks to several years (when linked to university graduate degree programs).

Research internship. This program provides specialized training on a topic such as plant breeding, pathology or entomology. In this program the trainee works closely with the researcher or group of researchers in the field selected. The time and content of training are determined by the expressed needs.

Service internship. This permits training in how to operate a genebank, seed laboratory, nutritional or soils laboratory, etc. This program is also tailored to the needs of the national program or trainee.

Production training. This course provides a five-month programmed training on how to grow a specific crop or groups of crops from seed to harvest. A new type of production training program, which emphasizes market-oriented production technology, is being developed at the AVRDC.

A brief overview of the training efforts of AVRDC are presented for the period 1975-87. Over 750 scientists, extension workers and graduate students from 40 countries have attended AVRDC training courses. The origin of training participants, occupational background, type of training and AVRDC program are indicated in Figure 2.

One area of expansion that is quite notable is the large number of requests for training in seed production and handling. The AVRDC is in the process of preparing a broader training

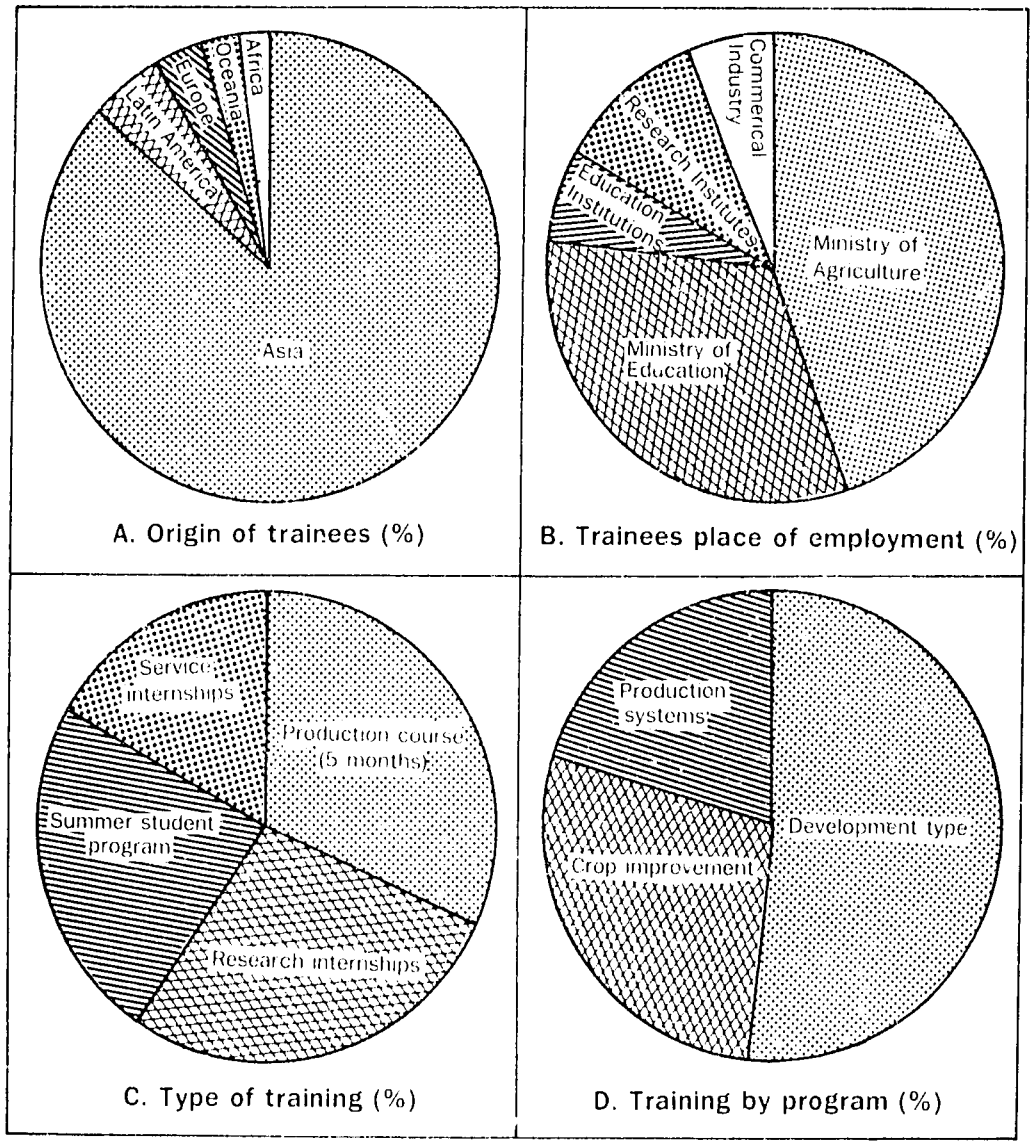

Figure 2. Training at AVRDC headquarters, 1975-87.

base in this field and has been granted a significant number of scholarships for this purpose. The facilities available at AVRDC for this specialized training are as follows:

- The Genetic Resources and Seed Unit building houses the AVRDC germplasm storage, laboratories and a classroom. There are three storage rooms with controlled temperature which provide 115 m^3 of long-term (-20°C frost-free), 193 m^3 of medium-term (2°-5°C, 40%-45% RH), and 254 m^3 of short-term (15°C, 40% RH) storage. In addition the facility contains a packaging room, a seed-conditioning room, laboratories, a drying yard, a computer room, an herbarium, a classroom and offices.
- The complex of laboratories and other seed-handling facilities are supplemented by actual field operations so that the trainees can experience the wide spectrum of seed technology at AVRDC.

Research Accomplishments and Future Thrusts

Crop Improvement Program

In the lowland tropics, the production of many vegetables is generally difficult, and sometimes impossible, due to high temperatures, excessive rainfall, high incidence of insects and diseases and severe leaching of soil nutrients. Being near to the equator, the length of day seriously limits the production of photoperiodically sensitive crops. High temperatures reduce fruit setting of tomatoes and can prevent the heading of cabbage. Tropical yields are often low because of the poor nutrient-holding capacity of the soil which may be aggravated by leaching rains. Soil and air-borne diseases and insects must be managed continually or crop failure can be expected. Upland and cool season production is usually much less risky than lowland, but the vegetable consumers are generally concentrated in the lowlands. Considering the generally poor infrastructure, it is necessary to produce near the population belt.

The goals of the Crop Improvement Program are to generate and provide genetic materials of wide adaptability, which reflect stable and profitable yield potential, contain certain resistance or tolerance to the most restrictive pests and diseases, and have enhanced market characteristics and nutrient content. The accomplishments and future goals of the program, presented according to specific commodities and/or discipline, are given below.

Chinese cabbage breeding. Heat-tolerant open-pollinated and hybrid materials have been developed. These lines carry improved resistance to downy mildew and turnip mosaic virus. They are of early maturity and yields of 20 to 30 t/ha during the hot humid season are quite common.

In the future, it is hoped that resistance to bacterial soft rot and improved seed production under tropical conditions can be achieved.

Mungbean breeding. Early, uniform maturing, high yielding (1.7-2.6 t/ha) materials have been developed. These new lines have reduced sensitivity to daylength and temperature, carry improved resistance to powdery mildew and Cercospora leaf spot, have an improved plant type which makes the pods protrude above the canopy for easier picking, and have reduced shattering potential.

Future plans include the search for greater tolerance to flood and drought conditions, and resistance to beanfly and storage weevil. It is hoped that the disease resistance of *Vigna glabrescens* can be incorporated into mungbeans through biotechnology. The goal is to combine higher yields, synchronous maturity and pest resistance thus reducing the cost of production and insuring greater crop security.

Pepper breeding. Although AVRDC has just begun pepper breeding, it has collected 5,000 germplasm accessions and surveyed the literature and research worker base to help develop an effective research program. The most used landraces of hot pepper have been exchanged.

In both hot and sweet pepper, it is hoped to increase resistance to the complex of viruses and other diseases which constrain pepper production in the tropics. In hot peppers, increased pungency, aroma and color is sought. In both types higher levels of genetic purity are desired through cleistogamy. The sweet or green pepper is primarily a temperate vegetable; thus, AVRDC aims to select genetic materials which will allow it to be produced reliably and profitably in the tropics.

Soybean breeding. Reduced sensitivity to daylength and temperature have allowed greater production of this valuable plant protein source in the humid tropics. The AVRDC has developed genetic materials of early, midrange and late maturity with high stable yields (2-3 t/ha). Resistance to bacterial pustule and downy mildew, and moderate tolerance to soybean rust have been found. Lines with good seed quality and resistance to shattering have been developed. The vegetable

soybean has been improved and promises to be a tropical substitute for green peas and green lima beans as a nutritious protein source.

Future thrusts include greater resistance to soybean rust, greater tolerance to drought and flooding, and improved seed quality. Improved oil quality of both grain soybean and vegetable soybean is being sought. Further improvement of the latter include larger seed size, reduced beany flavor and higher quality for consumers.

Sweet potato breeding. Sweet potato lines of early maturity (100 days), high root yield, high carotene, protein and dry matter have been developed which are adaptable to hot wet conditions. Yields of 15-20 t/ha in the hot wet season and 30-35 t/ha during the cool dry fall period are now common. A survey of sweet potato researchers and extensionists in the region provided valuable program guidance regarding flesh color, dry matter, size and shape that are most desirable for the region.

It is hoped that improved yield stability, greater adaptability and increased pest resistance can be achieved, along with improved storability, high dry matter and better nutritional quality, in the future.

Tomato breeding. Heat tolerant lines with resistance to bacterial wilt, tobacco mosaic virus and root knot nematode have been developed for fresh market and processing. During the hot humid season, yields of 35-40 t/ha have been achieved. Tropical tomatoes have improved firmness and fruit size is continually being increased.

In the future larger fruit size during hot weather, improved processing lines for the cool dry season, and improved firmness and color for fresh market and processing tomatoes are intended. Additional resistances to diseases will be incorporated into the most advanced breeding lines.

Plant pathology. New viruses and the hosts of viruses affecting pepper, tomato, soybean and mungbean have been detected. Sources of genetic resistance to various diseases have been found, and screening methods have been developed for use in the breeding program. Virologists have developed a virus-indexing scheme which will help make sweet potatoes safer to transfer to researchers requesting AVRDC genetic materials.

In the future more detection surveys are planned, greater elucidation of pathogens and virus strains, and even faster, more specific detection methods will be developed. The disease-yield relationship needs investigation. Greater disease resistance and tolerance is being sought for the principal vegetables.

Plant physiology. Contributions have been made to the greater understanding of the physiology of heat tolerance in tropic-grown vegetables, their plant-water relations, and the manner in which yield is influenced by tropical climate. Tissue culture techniques have significantly aided disease screening, germplasm storage and transfer, aside from their primary importance as tools in plant physiological studies.

Entomology. Sources of resistance to the defoliator, stink bug and beanfly in soybean and vine borer resistance in sweet potato have been located. Integrated pest management has been developed for the sweetpotato weevil and the diamondback moth in Chinese cabbage. The AVRDC entomology team is assisting in the development of beanfly- and bruchid-resistant mungbean lines. Techniques for the mass rearing of beanfly to facilitate, resistance breeding have been developed.

Future thrusts include the transfer of integrated pest control technology for diamondback moth and sweetpotato weevil to Asian countries. This phase requires an active participation of NARS extension and research personnel, and well-organized resources will be required along with an appropriate NARS commitment. Additionally, it is hoped that resistant breeding lines can be developed for beanfly, defoliator and stink bug in soybean, and bruchid resistance in mungbean.

Production Systems Program

The goal of this program is the development of effective and transferable production technologies for vegetable crops to improve nutrition and farm income in the tropics. The approach is to generate technologies requiring fewer resources, thus providing more possible alternative production systems to farmers, and to develop principles, information and methodologies which can be used by the NARS to improve the efficiency of their adaptation research.

The Production Systems Program is comprised of five specialties: crop management, cropping systems, nutrition, on-station testing and soil science. These specialties provide valuable agronomic input into the multidisciplinary efforts of the AVRDC.

Crop management. The emphasis is on cultural practices for the humid tropics. The critical period of weed competition in soybean, mungbean and tomato production was determined, and appropriate herbicides for hot, humid production were identified. Using temperature, solar radiation and precipitation as major determinants, the optimum planting dates for sweet potato were studied. Progress in solar heating of the soil through plastic coverings to achieve pasteurization and reduction of soil pests, improved cultural practices to reduce solar radiation injury, and low-cost drip irrigation, have been vital outputs of this group. Similar activities are intended for further refinement in the future.

Cropping systems. This group attempts to maximize the efficiency of available resources. It has contributed to improved nutrition home production systems, the search for new vegetables related to intensive production systems for tropical Asia, and a computerized vegetable data base on vegetable performance is being developed.

In the future this group aims to extend the data base on the improvement of vegetable production systems through best use of the resource base, elucidate the relationship between environment and yield of vegetables in the tropics, and develop, test and apply the expert system of a vegetable advisory service for national programs in the region.

On-station testing. This element cooperates with the host govenment NARS to develop methodologies for technology transfer and adaptation research. Over 600 cooperative trials have been conducted with local institutes. We hope to improve the efficiency of our systems through trials.

Nutrition. AVRDC wishes to strengthen the nutritional aspect of vegetables and develop methodologies to evaluate the nutritional impact through vegetable research. The data base on the nutritional content and methodology to evaluate the nutritional value of vegetables has been established. Application of this information will be extended to the NARS, especially for home gardening.

Soil sciences. The emphasis is to better understand the crop-soil relationship, such as the soil-water relationship, soil nutrient management and the effects of cropping patterns on soil properties. The development of improved soil management strategies have been the major activities of this group. In the future major emphasis is to be given to the development of principles and methods to reduce field-related stresses in vegetable crop production in the tropics.

Research Support

In the support of the Crop Improvement and Production Systems Programs, various departments, such as Chemistry, Genetic Resources and Seed Unit (GRSU), Computer Services, Office of Information Services, Experimental Farm and Library contribute vital inputs. Of these groups, the GRSU plays a direct role with the Crop Improvement and Production Systems Programs in field operations and is vital to the AVRDC thrusts as a germplasm, information and training center.

Genetic Resources and Seed Unit. During the past decade AVRDC has constructed a world class genebank, computerized its germplasm data base, and developed an inventory and seed distribution data base. The GRSU has characterized the germplasm collection of mungbean, soybean, Chinese cabbage and sweet potato accessions.

In the future the GRSU hopes to expand its genetic resources of new, as well as principal, vegetables, prepare and publish germplasm catalogues of its holdings, and conduct more research and training on seed technology.

Summary

The current achievements of the AVRDC may be summarized as improvements of genetic materials through greater adaptability, resistance or tolerance to pests, more stable and higher yields and improved morphology. Improvements in production systems have enhanced income potential for small vegetable growers.

The future is faced with enthusiasm as the scientific staff of AVRDC hopes to gather, evaluate and utilize an even wider array of adaptive genetic material for its crop improvement effort. Pest management based on the best use of natural agents, as well as chemicals with least damage to the environment, is to be accented. Input reduction, wherever possible, to allow profit maximization to the small holder will be a major activity. To insure sustainability, serious address must also be given to how vegetable production can be based on the philosophy of adequate but not excessive inputs such as fertilizers, pesticides, etc., in an effort to minimize damage to the environment yet still maintain profitability.

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Development of a Viable Vegetable Seed Industry in Southeast Asia

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Vegetable Seeds and Vegetable Farming

The vegetable seed industry, if functioning well, is closely interrelated to the size and development of commercial vegetable farming. The relationship is symbiotic, such that one cannot function well without the other.

Vegetable farming in Southeast Asia is now at a critical takeoff point, with significant differences in the stage of development for each Southeast Asian country.

The shift in the human diet from predominantly carbohydrates to a more balanced diet with animal and plant proteins, as well as minerals, vitamins and fibers from vegetables depends on a combination of two factors: the consumption and production of vegetables.

Vegetable consumption is dependent primarily on the eating preference of the people, an increase in their purchasing power and income elasticity of vegetables. The development of vegetable production is influenced by the availability of improved vegetable farming technology, including the accessibility of quality seeds. The increasing pressure of available farming areas in densely populated countries will gradually cause a shift from production of lower return grain crops to high value vegetable and fruit crops. Increasing urbanization will also lead to the growth of commercial vegetable production and decrease in backyard production.

The per capita annual production of vegetables in 1986 in Southeast Asia and other countries is presented in Table 1. Following is a brief overview of my impressions on the current situation in Indonesia, Malaysia, the Philippines and Thailand.

Indonesia

During a recent mission in Indonesia to study the development potential of the vegetable seed industry, I observed that: (1) the Indonesian Government has started to strengthen the horticultural sector and plans are being developed to establish a Directorate-General for horticulture, aside from the long-existing Directorate-General for food crops; (2) prices for most vegetables are increasing gradually, which indicates a higher increase in vegetable demand than in supply; (3) vegetable farming in the highlands and in some lowland areas of Java is on a fair level of technology, but can benefit greatly from further vegetable research; and (4) the vegetable seed sector is in great need of quality improvement in most areas.

Malaysia

My impressions about the vegetable industry in Malaysia are limited. There seems to be an increasing concern in Malaysia and Singapore about pesticide residue on fresh vegetables, which indicates a need for more research on insect and disease control other than from chemical pesticides.

Table 1. Per capita annual production of vegetables in 1986.

Country	Annual production (kg)
Southeast Asia	
Indonesia	21
Malaysia	30
Philippines	14
Thailand	60
Bangladesh	12
Burma	55
Vietnam	54
Others	
Asia (total)	81
Europe (total)	141
China	98
India	61
Japan	127
Taiwan	130
USA	121

Source: FAO 1986.

Philippines

In the Philippines vegetable consumption is relatively low. However, a rising trend of vegetable prices can still be observed, which suggests a faster increase in vegetable demand than in supply. The general level of vegetable farming expertise needs considerable improvement.

Thailand

Among the Southeast Asian countries, Thailand has a relatively high per capita vegetable consumption and it is still rising. Vegetable production is keeping up with demand, and vegetable farming in the central part of the country is expanding mostly in areas previously planted with rice. There is a gap in vegetable farming technology between the main regions and the central provinces, with the latter showing the most advanced technology. There is still ample room for varietal improvement.

Assessment of the Recent History of the Vegetable Seed Industry

In general vegetable seeds in the region have been considered as a commodity product and not as a quality product. The majority of the seeds being sold are unselected by-products of fresh vegetable farming. Formerly, more consistent seed quality could be obtained from farmers' selections in the southern provinces of China, but the political developments in China from 1950-80 have greatly disturbed the stability of this seed supply system.

During the last 20 years, imported hybrids of brassicas, mostly from Japan and Taiwan, such as white cabbage and Chinese cabbage have been widely accepted because of their superior heading uniformity and, in some varieties, superior heat-tolerance for lowland conditions. This penetration of high-priced hybrid seeds signifies a crucial shift from commodity to quality seeds.

We have found very little of the effective combination of the vegetable farmer making his own selections and developing a small quality seed business out of his own seeds. This combination has led to the development of several of the well-known vegetable seed companies in the

Netherlands, France and Japan during the last 50 to 100 years. Maybe the relatively low social status of the vege able farmers had an adverse effect on this potential development.

Until recently, most governments in Southeast Asia have given vegetable and fruit crops a low priority. Most attention had been given to the major grain crops. The very limited government support in research, such as in plant breeding, farming systems, postharvest handling, as well as in horticultural extension, has kept the horticultural sector in a low quality status quo. Thailand is an exception since the private sector, which is mainly the farmers themselves, has improved the quantity and quality of horticultural production even with very limited government support.

The effectiveness of the AVRDC research outputs is reduced by the weak structure of the public horticultural research programs in the region. It should be noted that the development of the horticultural sector in Europe and North America was supported by major research efforts of the governments in Europe and of the land grant colleges in the USA during the 1880-1940 period.

Current Status

Marketing

Most importantly, the more advanced vegetable farmers are slowly beginning to recognize the value of quality seeds against commodity seeds. Seeds of hybrid varieties such as white cabbage and Chinese cabbage are being imported, but the trend is also spreading to traditional local seeds, such as eggplants and heat-tolerant tomato varieties, tropical lowland brassicas, and some of the major lowland cucurbits such as tropical pumpkins (*cucurbita moschata* Duchesne) bitter gourd (*Momordica charantia* L.), luffa (*Luffa aegyptiaca* and *L. acutangula* Miller) and tropical cucumber (*Cucumis sativus* L.). In most of these crops, there is a need for high performance hybrid varieties for the more advanced and well-financed farmers, and stable open-pollinated varieties at a lower price level for the less developed farmer groups.

Seed Production

Vegetable seed production of controlled tropical varieties under contract farming schemes has shown good progress in Southeast Asia during the last five years.

Tropical brassicas. Building up from the experimental work of the seed technology group of the University of the Philippines at Los Baños, the private sector has been able to expand the seed production area in the Benquet highlands (1,200 m above sea level) to more than 100 ha with over 500 contract farmers. An average yield of 600 kg of seeds/ha, which is increasing by 5% to 10% each year, was obtained.

Thailand lacks suitable highland areas for seed production and, therefore, an increase in seed production is moving at a slow pace, especially because of the constant struggle with the diamondback moth (*Plutella xylostella* L.) in the long-standing seed crops, ranging from four months for the early-maturing crops, such as pak-choi types, to six months for radish.

Cucurbits and solanaceous crops. Most of these long-established local crops do not pose major problems, and the seeds can easily be produced in irrigated lowlands during the dry season. "If fruits can be produced then seeds can also be produced."

In some cucurbits, such as pumpkin and watermelon, additional hand pollination (in open-pollinated varieties) is used, when the population of natural pollinators is too low. Commercial bee keeping is not so well developed yet as in other parts of the world. Some seed companies are beginning to develop their own bee-keeping activities.

Variety Improvement and Plant Breeding

The commodity seed concept has long prevailed in the region, even to the point that government seed quality control programs are mainly concerned about seed germination, but not about varietal quality.

On the farmer's level, awareness of varietal quality is beginning to develop. We have observed in several markets a 'seed lot quality awareness'. Farmers become aware of the good varietal quality of a given seed lot in the hands of a local dealer, wholesaler or importer and attempt to procure seeds from that lot. As soon as the lot is exhausted, the search for another seed lot of acceptable quality starts all over again through a trial and error process. This environment offers good potential for seed companies to maintain and supply stable selections at price levels that take into consideration the higher value of dependable seeds for the farmers.

In selected crops, the region has a number of farmers' selections made by quality-conscious farmers. They are sometimes distributed under small-scale distribution patterns. These selections are always an interesting source of material for professional plant breeders.

Hybrid variety development. In selected situations the superiority of hybrids versus open-pollinated varieties in tropical vegetables is very convincing in terms of performance/cost ratio. It is often said that hybrids will excel under adverse growing conditions. Well, we have plenty of adverse conditions in vegetable farming in the tropics, particularly in terms of extreme temperature and relative humidity. We, therefore, still foresee a rapid development of hybrids, especially in the longer cycle brassicas, such as white cabbage and Chinese cabbage, and in many local cucurbits and solanaceous crops. The hybrids will also permit a quick combination of available genetic disease tolerance, which is the top priority of any tropical vegetable plant breeder.

Components of a Successful Vegetable Seed Industry

Vegetable farming systems and subjective preferences for types of vegetables vary considerably from country to country and, to a lesser degree, within the same country from one region to another region.

It is, therefore, necessary to work on a per country basis. At this early stage of development, it is important to have a sufficiently large potential domestic market. This will include the major countries in the region, such as Indonesia, the Philippines and Thailand, and may include at a later stage, Vietnam, Burma and Bangladesh, depending on the development of the political situation.

Another important consideration is the determination of the national government to develop the horticultural sector, by providing national horticultural research and other infrastructure support. As mentioned earlier, the seed industry develops in a symbiotic relationship with the whole vegetable industry

Development of a Competent Seed Industry

During the last 40 years, the key words in the vegetable seed industry of the developed European countries, Japan, the USA, and more recently in the Republic of Korea and Taiwan, China are variety development and quality control.

In Japan after World War II, the development of hybrid cabbage and Chinese cabbage based on self-incompatibility systems, and in Taiwan the outstanding work on hybrid melons and watermelons set the trend of variety development. In Southeast Asia the same developments can and should be repeated.

Variety development. Simple mass selection improvements and hybrid variety development are of utmost importance. This must be done with a knowledge of the specific needs of the

consumers and the farmers. Plant breeding cannot be done in isolation; it requires a permanent dialogue with the producers and consumers. This is the main reason that public programs rarely develop a commercially successful variety; they are invariably weak in linkage to the farmers.

The amount of local expertise in commercial vegetable plant breeding in the Association of Southeast Asian Nations (ASEAN) countries is still limited. For the next 5 to 10 years some outside expertise is needed.

Domestic seed production capability. A seed industry must have its own local seed production base. All major seed-producing countries started with a local production base. As the seed industry develops, some internationalization of the production may be developed with multiplication of the locally developed mother seeds in another country, especially with favorable climate and/or cost conditions. However, the need for a capable local seed production base will always remain. For the first few years, some outside expertise is helpful to avoid too many beginners mistakes. However, we don't consider that domestic seed production will pose major technical problems.

Quality control standards. Seeds are the most crucial input for a farmer and, therefore, only quality seeds of reliable and predictable performance are worthy of the farmers' confidence. Therefore, the seeds sold to the farmers should always meet high quality standards, i.e.trueness to type as labeled and should exceed the minimum germination standards at the time of purchase.

The Public Sector and the Seed Industry

The vegetable industry, in general, and the seed industry, as an integral part of it, can develop much faster with a strong institutional support system from the public sector.

Research

Only strong national research programs can tackle areas like: crop protection or, better still integrated pest management (IPM) for vegetables; cropping systems; fertilizer trials; spacing experiments; trellising systems; crop rotation; drainage systems for rainy season lowland vegetable farming; and basic plant breeding research, especially on genetic disease resistance.

These research areas can best be done by the public sector for the next 10 years. The young seed industry is financially not capable of making the necessary investments in equipment and manpower for this kind of long gestation research, some of which can be done on a regional basis.

We would like to recommend a structure by which the private sector (farmers, food processors and seed companies) will have some influence in planning research directions and priorities of the national programs. We do not need any more ivory towers of research; we need research that will really help the farmers.

Most agricultural research institutes in the Netherlands have a supervisory board, composed equally of board members from the public and private sectors; and they are producing positive results.

Education

As mentioned earlier, we are short of competent horticultural researchers, especially in plant breeding in agricultural universities and colleges. More emphasis should be given to horticultural plant breeding in these institutions.

Quality Regulations

Both the farmers and the bona fide seed suppliers will welcome better government regulations on the quality control of all horticultural propagation materials. The main emphasis on seeds

should be varietal quality control. What is the use of seeds with 90% germination when the farmer finds out after one or two months that radish plants do not form roots or pak-choi flowers too early?

A strong program by the national or provincial governments in variety testing and evaluation programs can also have a major educational effect on the variety awareness of the farmers. It is important that farmers can recognize quality seeds from commodity seeds.

Extension

Except in Taiwan, which has built up an excellent extension support system for all kinds of farmers, the extension in horticultural crops in the Region leaves much to be desired. The main bottleneck seems to be the low level of incentive and/or lack of mobility to visit the fields.

In the Netherlands the horticultural sector has a good government extension system. We have seen rapid growth in two alternative farmer information systems, i.e. private extension companies and farmer study groups. For a flat fee per hectare, the private extension company sends highly qualified experts to the fields or greenhouses on a regular schedule to advise the farmers. On the other hand, the farmer study groups, which are groups of farmers of the same crop in a district, usually initially organized by an extension worker, meet once a month during the evening to exchange information about all aspects of their crops. Sometimes they organize field trips. This system has become widespread and is considered a major means of increasing the technology level of the vegetable farmers in the Netherlands.

Domestic Seed Production

Domestic seed production by contract farmers starts to operate under high cost levels, as usual at the beginning of 'the learning curve'. It will take 5 to 10 years of intensive extension work by the contracting seed company to raise the seed yield levels and bring the seed cost down to more competitive levels. During this period the 'infant' seed production industry is very vulnerable to competition from low-cost production countries or sometimes even dumping at 'political prices'.

For a country that wishes to nurture its domestic seed industry, some restrictions on seed imports through quotas and/or tariffs during the 'learning' period should be considered.

AVRDC and the Regional Seed Industry

Tomato lines with bacterial wilt tolerance and high temperature fruit-setting ability, and Chinese cabbage lines with tolerance to softrot and turnip mosaic virus (TMV) and heading ability under heat stress conditions have made and will make important contributions to the regional variety improvement programs. I have recently observed the widespread penetration of tomato varieties, Radna and Intan in Java, which both originated from AVRDC breeding lines. The exchange of information between AVRDC researchers and the seed industry plant breeders has also been very helpful.

The major concepts of a regional research network system is strongly supported by the seed industry because we know from experience that it can produce positive results, if handled effectively. Several major European and American vegetable seed companies have developed this concept over the last 15 years.

In the case of the company I used to work for, which is the largest vegetable seed company in Europe, the central plant breeding station for subtropical solanaceous and cucurbit crops is located in southern France. There are satellite stations located in the major vegetable production areas around the Mediterranean, namely: southern Spain, for under-plastic winter crop production; Morocco, for outdoor winter crop production; Crete (Greece), for winter and summer production; and Turkey, for year-round crop production.These satellite stations have dual functions. They

do prerelease testing of materials from the central station and provide the central station plant breeders with a flow of information on the variety requirements for their local markets.

We have to bring the AVRDC research work in closer touch with the vegetable farmers of the region. Aside from the regional research network system, which is the main point of discussion of this workshop, I would like to make a few suggestions how this goal can be advanced:

1. Each cooperating country in the Region can have an AVRDC Advisory Council, composed of public and private sector representatives who have close contacts in the vegetable farming community. This Council shall advise about the nature and scope of constraints in vegetable farming in their respective country. This information network can greatly improve the effectiveness of AVRDC research for the Region.
2. Besides the AVRDC Board of Directors, a separate Advisory Research Council, composed of leading vegetable researchers in the Region, preferably both from public and private sectors, can make recommendations about the priorities and directions of vegetable research at AVRDC.
3. It is my contention that all major improvements in vegetable farming and research will be developed in and for the commercial vegetable farming sector and not in the backyard farming sector. Backyard farming will ultimately benefit from these developments in commercial vegetable farming, mainly through increased availability of better seeds.This has happened in the developed countries.

I would like to express the hope that the public and private sectors, both at the regional and national levels, can develop a constructive cooperation. This is crucial to give the best possible support to the commercial vegetable farmers of Southeast Asia and to increase the supply of quality vegetables in the market.

Summary and Recommendations

The commercial vegetable industry of Southeast Asia is at a critical point of either developing, like in Taiwan and the Republic of Korea during the last 30 years, or maintaining the status quo with limited potential for growth in the volume of production and per capita consumption.

The private sector will follow and support these developments in the vegetable seed industry, with improved quality and quantity of seeds. The government vegetable seed programs will only be of minor importance because of their lack of market orientation.

The quality and volume of tropical vegetable farming can be developed more rapidly with strong regional and national public programs for research specifically on plant breeding, crop protection and farming systems, and comprehensive quality seed regulations including varietal quality control and special extension programs for horticultural crops.

Research programs for horticultural crops are more effective when program directions and priorities are determined jointly by the public and private sectors.

Acknowledgments. I wish to thank AVRDC for its important germplasm contributions to the country programs and to the seed companies with plant breeding programs. Specifically, I would like to thank Dr. George A. Marlowe Jr. and his staff for inviting me to present in this workshop the views of the young seed industry.

Literature Cited

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Discussion: Review of Regional Vegetable Research

Hashim B.A. Wahab: What is the plan of AVRDC in focusing research in the postharvest areas?
G.A. Marlowe: The AVRDC, due to budgetary restrictions, has several staffing pattern deficiencies; such as postharvest, agricultural economics, marketing, etc. Fortunately, other countries in the region have strong resources in these fields and through networking these overall program deficiencies can be overcome for the general good of the region's needs.

S. Groot: Please tell us some more about AVRDC's plan to work on other vegetable crops, besides Chinese cabbage, tomato and peppers.
G.A. Marlowe: AVRDC bases its breeding program on carefully selected goals; when these goals have been largely achieved such as in mungbean and Chinese cabbage, the program is scaled down or placed on maintenance research status and a new crop is selected for major emphasis. Pepper breeding is an example of a new crop emphasis as Chinese cabbage, one of the more successful programs, has now been placed on a maintenance level.

J.T. Sykes: In view of AVRDC's limited core funding to meet demonstrated needs such as postharvest, economics, etc; what is the current position regarding CIP assuming responsibility for sweet potato and could there be some benefits accruing to AVRDC as a result?
G.A. Marlowe: AVRDC has been involved with sweet potato for 15 years and a network has been developed. A position paper is being prepared for the AVRDC Board on AVRDC's future work with sweet potato. Possibly, AVRDC will continue to do training and some breeding of sweet potatoes. What will serve the Asian farmer best is the major issue.

P.A. Batugal: In response to the expressed need for more information on vegetables, I wonder about AVRDC's reaction to the following: (1) Establishment of an Asian Vegetable Journal for publication of research results on vegetables; (2) Establishment of an Asian Vegetable Association to encourage interchange of ideas and experiences and research results which through regular meetings and workshops would tackle research and development problems. This association can also provide the funding requirements of the Asian Potato Journal. (3) Both the Asian Vegetable Journal and the Asian Potato Association can be coordinated by and possibly be headquartered at AVRDC.
G.A. Marlowe: These are all worthy suggestions for improved communication but I don't feel that AVRDC should replace other linkages. Our goal is to strengthen them. It may be most appropriate for AVRDC to assist in the development of a research brief 'Newsletter' for the region which could funnel research summary information, news of meetings, etc. This would be a supplement to existing journals which are usually struggling for effective publication inputs.

P.A. Batugal: In connection with AVRDC's offer of assistance and collaboration, the SAPPRAD would like to propose a collaboration on the abstracting and publication of published and unpublished reports on sweet potato in SAPPRAD countries.
B.T. McLean: The matter has been recently discussed with CIP and will be taken into consideration as AVRDC prepares its forthcoming strategic plan.

P.A. Batugal: I noticed that sweet potato was not included in the list of top 10 vegetables of Indonesia, Malaysia and Thailand. Is this because in their decision to list the top ten vegetables, sweet potato was considered more as a food crop rather than as a vegetable?
J.-Y. Yoon: Yes, I think so.

T.C. Yap: I personally feel that it is a wise approach to serve the region that AVRDC now also works on vegetable soybean and pepper, especially hot pepper. Farm size in the region is normally very small, and therefore it is not profitable for the farmer to plant grain soybean in the region even if the yield is able to reach 2 t/ha. Currently the yield of soybean in Southeast Asia is less than this figure.

B.T. McLean: AVRDC copublishes information with other institutes which is important to make available but which AVRDC does not have the resources to undertake by itself. For example we have recently copublished the sweet potato proceedings in French through CTA and ACCT. A monograph by Dr. Talekar on the beanfly is currently being copublished by an Indian publisher. We are very pleased to discuss additional copublication proposals with any of the participants at the Workshop.

C.L. Luh: I would like to comment on AVRDC's sweet potato program for the participants to understand why sweet potato was selected to study. Sweet potato can feed more people than any other crop from the same piece of land. Today, sweet potato is considered as a health food for babies as well as for senior citizens. Young sweet potato tips are a very important leafy vegetable crop during the hot summer season because there is no chemical residue on leave and it is safe for people to eat.

Saharan H. Anang: I would like to suggest to AVRDC to carry out research with participating countries in which AVRDC plays a cordinating role. This will reduce the financial burden and solve the man power problem.

J.-Y. Yoon: Is low germinability of vegetable seed common in Southeast Asian countries? If so, what are the causes?
S. Groot: Low germination is a problem with traditional farmer- produced seeds. Adequate drying and moisture-proof packaging can solve this problem.

Subijanto: (1) The proper terminology for General Directorate is the Directorate General. (2) AVRDC's mandate includes strengthening the national research programs which does not need to reduce the effectiveness of AVRDC research outputs as you mentioned. (3) What do you mean by 'mother seed'? (4) Could you specify which research belongs to your 'ivory tower research' done by which research institutes? (5) Could you comment on your statement: 'the government vegetable seed programs will only be of minor importance because of their lack of market orientation'. Which government programs do you mean? Apparently you lack understanding on the seed system of the governments.
S. Groot: (1) The incorrect reference to the Directorate-General in Indonesia will be corrected in the final editing. (2) An example of inadequate effectiveness of national programs is the limited ability to convert AVRDC-provided germplasm into marketable varieties for each country by using market-oriented applied plant breeding methods. (3) Mother seed is another term for stock seed or foundation-seed which is the generation before commercial seed. (4) The term 'ivory tower' research has been used to describe in general terms the research that is done more for academic purposes than for direct research support to the farmers. (5) In spite of long-term government efforts in vegetable seed production in the region, I am not aware of any country where government-produced seed satisfies more than 1% of the total requirements. I do not foresee any major changes in this situation in the near future.

N.S. Talekar: What is the total volume (US$) of import of seeds into Southeast Asia and export out of this region?
S. Groot: The requested figures are not available to me here. I estimate total imports of Indonesia, Malaysia, the Philippines and Thailand to be in the US$10-15 million range and the exports US$2-3 million, mainly custom-produced hand-pollinated hybrid seeds from Thailand.

R.L. Villareal: Why did you establish your East-West Seed Company in the Philippines first instead of the other countries in Southeast Asia?

S. Groot: At the start, our intended work to upgrade the tropical vegetables seed business looked very complicated. We decided to start in the country, where no language barrier existed and, therefore, most needed information was readily available.

Ma. F.D. Tiamzon: Regarding your recommendation no. 1 concerning the setting up of an AVRDC Advisory Council in each of the participating countries wherein constraints/problems about vegetable farming can be discussed, this is to inform the workshop participants that for the past years now a Technical Working Group (TWG) on vegetables exists in the Philippines wherein both government and the private sectors are represented as well as all research leaders working on vegetable research and development from throughout the country. During their last meeting early this year, the private sector committed to participate and support the national seed program. Each entry (seeds they have developed) to be tried in the regional trials will have to pay a US$150 entry fee. If a network of Advisory Councils were established, the TWG could be tapped as the AVRDC Advisory Council for the Philippines.

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Regional Collaborative Research Potential

Export Market Potential of Vegetables from Southeast Asia

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Introduction

During the last decade most of the economies in the Far East, centering in the ASEAN countries, showed a good performance. The fairly high economic growth rate ranged from 3% to 9% per annum. Although economic growth in most of these countries was attributable to the expansion of agricultural production, especially of rice which is the staple crop for all nations in the region, in some countries the progress has been made in industrialization by supporting the expansion and the diversification of agricultural production.

In recent years a noticeable trend in the agricultural sector of the region has been that populous countries such as India and Indonesia, which once were the leading food importers in the world, have nearly doubled their output of food grains in the past 15 years and have begun to export or to have the potential to export rice. Burma, Pakistan, the Philippines, Sri Lanka and Thailand also increased their output of food grains in the last 15 years by more than 50%.

Such an increase in food production has apparently induced some of the governments to encourage farmers to diversify land use. In some countries more careful supports have been extended to the producers of crops other than rice, such as food legumes like soybeans, vegetables and fruits, in order to increase the value of the agricultural production and to improve the nutritional status of the people. Additionally, with industrialization in the relatively advanced countries, the expansion of the urban area has brought about an increase in demand for more nutrient foods like livestock and horticultural products.

It seems that another important factor has had a significant influence on the diversification of agricultural production in the Far East. We can witness the increased demands for livestock and horticultural products in both the developed and developing regions in recent years. In some middle-income countries, where economic performance has been good in recent years, the people, particularly those in the urban areas, whose earnings have gone up with economic development tend to spend a larger percentage of their food budget on these commodities than on such basic staple foods as rice. Thus, increases in the demand for livestock and horticultural products are expected in both domestic and international markets in the near future. Further, in recent years demands for imported fruits and vegetables have steadily increased in the developed North American countries and have dramatically increased in Japan due to the remarkable increase in value of the Japanese yen, and these increased demands should provide the opportunity for increased exports of fruits and vegetables for some countries in Southeast Asia.

However, the farmers producing fruits and vegetables in Southeast Asia are generally small, low-income farmers, who tend to utilize less advanced technology such as poor seeds and traditional cultivation techniques. Some improved seeds and cultivation techniques have been introduced by a few progressive farmers, who are assisted by foreign seed companies to produce these crops for the export market. The assembly and transportation of these products from many small farmers to the market is a major problem. Poor postharvest handling and packaging of the produce at this stage of the marketing process often cause a high percentage of loss.

As diversification of agricultural production continues in some Southeast Asian countries, many problems should be solved technologically and institutionally in order to expand production

and trade of vegetables. This paper will review the main features of vegetable production and their export and import in the Far East. Some consideration will be given to the factors which are responsible for the changes that have taken place in the vegetable situation in the last 5 to 10 years.

Further, in order to assess the future prospects for an expansion in trade of vegetables, the present situation of various markets for vegetables of the region will be examined, particularly that of the Japanese market, one of the major outlets for export of vegetables from Southeast Asia.

Current Vegetable Production and Trade

Production and Export

In the decade from 1975 to 1985, global vegetable production increased 2.2% per annum, showing a deceleration of increasing rate in the latter half, i.e. 2.6% from 1974-76 to 1979-81 and 1.7% from 1979-81 to 1983-85. In general the vegetable production growth rate in the developing market economies in the period observed was higher than that of the developed market economies, and the Far East region showed a relatively higher rate of production among the developing market economies (Table 1).

In the Far East, which for purposes of this discussion includes most countries east of Pakistan but excludes Japan, Taiwan, China and the centrally planned economies, the increase in vegetable production showed a mixed picture. The annual growth rates of output ranged

Table 1. Vegetable production in Asia.

Area/Country	Production[z]			Share in production[x]			Annual growth rate		
	1974-76 a	1979-81 b	1983-85 c	1974-76	1979-81	1983-85	b/a	c/b	c/a
	('000 t)			(%)			(%)		
World	567,379	645,011	689,679	100.0	100.0	100.0	2.6	1.7	2.2
Developed									
Market economies	161,326	167,420	173,736	28.4	26.0	25.2	0.7	0.9	0.8
North America	43,320	44,754	48,737	7.6	6.9	7.1	0.6	2.1	1.3
Western Europe	94,980	98,279	99,513	16.7	15.2	14.4	0.7	0.3	0.5
Japan	17,838	18,529	18,856	3.1	2.9	2.7	0.8	0.4	0.6
Developing									
Market economies	128,949	160,566	177,496	22.7	24.9	25.7	5.5	2.5	3.6
Far East[y]	59,687	75,331	83,343	10.5	11.7	12.1	4.8	2.5	3.8
India	40,408	49,938	56,267	(68.9)	(66.3)	(67.5)	4.3	3.0	3.7
Korea, Rep. of	6,514	9,505	9,325	(10.9)	(12.6)	(11.2)	7.8	-0.5	4.1
Thailand	2,779	2,853	3,084	(4.7)	(3.8)	(3.7)	0.5	2.0	1.2
Pakistan	2,301	2,495	3,073	(3.9)	(3.3)	(3.7)	1.6	4.2	3.3
China, Taiwan	2,298	3,073	3,041	(3.8)	(4.1)	(3.6)	6.0	-0.3	3.2
Indonesia	2,503	2,604	2,846	(4.3)	(3.5)	(3.4)	0.8	2.2	1.4
Bangladesh	1,883	2,003	2,400	(3.2)	(2.7)	(2.9)	1.2	4.6	2.7
Burma	1,742	1,992	2,178	(3.0)	(2.6)	(2.6)	2.7	2.3	2.5
Philippines	1,429	2,108	2,104	(2.4)	(2.8)	(2.5)	8.1	-0.1	4.4
Nepal	477	612	647	(0.8)	(0.8)	(0.8)	5.1	1.4	3.4
Malaysia	433	477	487	(0.7)	(0.6)	(0.6)	1.9	0.5	1.3
Sri Lanka	244	357	409	(0.4)	(0.5)	(0.5)	7.9	3.5	5.9
Hong Kong	179	189	163	(0.3)	(0.2)	(0.2)	1.1	-3.6	-1.0
Singapore	39	39	32	(0.1)	(0.0)	(0.0)	0.0	-4.8	-2.2

[z]Vegetable production includes potatoes. [y]China, Taiwan is not included in the Far East. [x]Figures in parentheses show the share of production of each country as percentage of the regional total. Sources: FAO 1974-1985 and TPG 1974-1985.

from -2.2% to 5.9%, with an average rate of 3.8%. The highest rate of 5.9% was achieved by Sri Lanka, the smallest producer in the region excluding Hong Kong and Singapore, and the Philippines and the Republic of Korea followed. A negative growth rate was registered in only two countries, Hong Kong and Singapore. This declining trend of production has appeared since the beginning of the 1980s. FAO statistical data indicate a stagnation of production in the first half of the 1980s in the Republic of Korea and the Philippines and production in the Taiwan, China is likely to show the same trend (FAO 1974-85, TPG 1974-85).

The largest vegetable producer is India with a 68% share of the region, followed by the Republic of Korea with an 11% share of the 1983-85 production. The order of countries, including Taiwan, China, based on the size of production showed little change in the last decade in spite of the diverse rates of growth among countries. The only exception was Indonesia which slipped from its fourth rank in 1974-76 to sixth in 1983-85.

Thus, from 1974 to 1985, vegetable production in the Far East registered a relatively higher rate of growth compared with other developed and developing regions, although there were diverse growth patterns among countries in the region. Since cereal production, the mainstay of agriculture in the region, made great strides in the same period, it may be difficult to maintain that the expansion of vegetable production has changed the pattern of agricultural production in the region. However, in some middle-income countries, such as the Republic of Korea and Malaysia, where the production of cereals has been stagnant recently, it seems that the expansion of vegetable production has positively influenced changes in the production pattern. For instance in the Republic of Korea, where productive resources have shifted from farming to nonfarming sectors in recent years, the areas under vegetables as percentage of the total planted areas of crops increased from 6.6% in 1974-76 to 10.4% in 1983-85, whereas the share of areas under cereals declined from 71.1% to 70.0% in the same period. Certainly part of the explanation for this change is that statistical data before 1979 is not entirely tenable and there has been a switch from production of less productive vegetables to more productive ones.

In spite of the recent increase in production, generally most of the vegetables produced in the region are still for domestic consumption and the rate of vegetables consumed domestically to total production is estimated at around 99%. According to some indicators, however, it seems that the percentage of vegetables exported shows an upward trend. For example, the quantities of vegetables exported as percentage of total production for selected countries in the region in recent years are generally higher than the corresponding figures in the mid-1970s as shown in Table 2.

Vegetable Import and Export

In 1983-85 the total value of vegetables exported from the Far East was US$1,372.3 million or 14% of the world vegetable exports (Table 3). If the value of vegetables exported from

Table 2. Vegetable export as percentage of production.

Country	1975-77			1983		
	Export		Production	Export		Production
	a	b	a/b	a	b	a/b
	('000 t)		(%)	('000 t)		(%)
India	127	36,253	0.35	–	–	–
Indonesia	24	2,067	1.16	46	2,229	2.06
Korea, Rep. of	28	4,319	0.65	–	–	–
Malaysia	67	427	15.69	74	465	15.91
Philippines	4	1,307	0.31	4	1,443	0.28
Singapore	–	–	–	1	37	2.70
Thailand	14	2,287	0.61	51	2,531	2.02

Sources: Information for the 1975-77 period is from FAO Food Balance Sheets and figures for 1983 are from FAO RAPA 1985.

Table 3. Vegetable exports.[z]

Area/Country	1974-76 Total agricultural exports a	1974-76 Vegetable exports b	1974-76 b/a	1979-81 Total agricultural exports a	1979-81 Vegetable exports b	1979-81 b/a	1983-85 Total agricultural exports a	1983-85 Vegetable exports b	1983-85 b/a	Annual growth rate 79-81/74-76	Annual growth rate 83-85/79-81	Annual growth rate 83-85/74-76
	(US$ million)		(%)	(US$ million)		(%)	(US$ million)		(%)	(%)		
World[y]	114,098.1	(100.0)[w] 4,905.1	4.30	207,756.5	(100.0) 9,543.5	4.59	198,257.8	(100.0) 9,685.6	4.89	12.2	-1.2	6.3
Developed market economies	76,296.9	(73.5) 3,603.4	4.72	143,794.0	(71.6) 6,759.9	4.70	133,817.7	(68.6) 6,647.0	4.97	13.4	-0.4	7.0
North America	27,142.3	(11.3) 549.6	2.02	48,245.6	(12.2) 1,156.6	2.40	43,766.5	(9.9) 960.3	2.19	16.0	-4.4	6.4
Western Europe	39,862.7	(60.9) 2,969.0	7.45	79,821.3	(56.9) 5,373.0	6.73	76,277.5	(55.6) 5,381.3	7.05	12.6	0.0	6.8
Japan	371.4	(0.9) 41.7	11.23	904.1	(1.0) 90.5	10.01	863.1	(1.2) 115.2	13.35	16.8	13.7	11.9
Developing market economies	37,801.2	(25.9) 1,268.4	3.36	63,962.5	(28.4) 2,683.6	4.20	64,240.1	(31.4) 3,038.6	4.73	16.2	3.2	10.2
Far East	9,903.8	(10.3) 504.4	5.09	18,466.1	(13.1) 1,238.5	6.71	19,108.5	(14.2) 1,372.3	7.18	19.7	2.6	11.8
Far East[x]	10,812.6	(100.0) 698.3	6.46	20,342.6	(100.0) 1,717.2	8.44	21,143.0	(100.0) 1,765.9	8.35	19.7	0.7	10.9
Thailand	1,713.6	(43.11) 300.7	17.55	3,349.4	(43.7) 751.2	22.43	3,468.7	(44.8) 791.1	22.81	20.1	1.3	11.4
China, Taiwan	908.8	(27.8) 193.9	21.34	1,876.5	(27.9) 484.5	25.82	2,034.5	(22.3) 393.6	19.35	19.8	-4.8	12.5
Korea, Rep. of	311.3	(7.3) 51.1	16.41	595.5	(7.6) 130.9	21.98	575.2	(7.0) 123.8	21.52	20.7	-1.4	10.3
Hong Kong	300.7	(3.5) 24.7	8.21	711.0	(5.6) 96.7	13.60	1,291.1	(6.9) 121.8	9.43	31.4	5.9	19.4
India	1,614.8	(3.7) 26.1	1.62	2,433.6	(2.8) 48.1	1.98	2,322.6	(4.3) 76.0	3.27	13.0	12.1	12.6
Singapore	535.2	(2.9) 20.4	3.81	1,496.4	(2.5) 42.4	2.83	1,808.6	(3.7) 66.0	3.65	15.8	11.7	13.9
Indonesia	1,029.0	(2.0) 14.0	1.36	2,281.5	(3.3) 56.7	2.48	2,321.4	(2.3) 41.5	1.79	32.2	-7.5	12.8
Malaysia	1,867.4	(–) –	–	3,463.8	(1.2) 20.7	0.60	4,040.6	(1.4) 24.9	0.62	–	4.5	–

[z]SITC code 054 and 056. [y]Excluding centrally planned economies. [x]Including Taiwan, China. [w]Figures in parentheses show the share of vegetable exports of each region and country as percentage of the world and regional total, respectively. Source: UN 1974-1985 and COA 1974-1985.

Taiwan, China is added to the above figure, total exports from the developing market economies in the Far East captured 18% of the world total. Thailand has continued to hold the first rank in the value of vegetable exports, with 35.4% share of the region in 1983-85, and it is followed by Taiwan, China, the Republic of Korea, Hong Kong, India, Singapore and Indonesia with 22.4%, 7.0%, 6.9%, 4.3%, 3.7% and 2.3%, respectively.

The importance of vegetable exports as percentage of total agricultural exports of the developing market economies in the region was 8.3% in 1983-85, against 5.0% and 4.7% in the developed and developing market economies of the world, respectively. Vegetable exports contribute more to the total export earning of agricultural products among the large vegetable exporters such as Thailand, Taiwan, China, the Republic of Korea and Hong Kong, compared with the small exporters. In 1983-85, Thailand achieved the highest ratio of vegetable exports to total agricultural exports (23%), and was followed by the Republic of Korea (21%), Taiwan, China (19%) and Hong Kong (9%), while the corresponding figures of the small exporters like India and Indonesia were 3% and 2%, respectively (Table 3).

It should also be noted that the importance of vegetables in total agricultural exports of the developing nations has increased more steadily compared with the developed regions as a whole. Although the expansion of vegetable production generally has little influence on the pattern of total agricultural production in the region, it seems that vegetables have gradually attained a larger weight in the total value of agricultural exports in place of traditional exports such as cereals and agricultural raw materials. This increase in importance of vegetables in exports of agricultural products in recent years may be attributable to the relative decline in the prices of traditional export commodities.

Exported vegetables consist of unprocessed (fresh and simply preserved) and processed (preserved and prepared) categories. In 1983-85 unprocessed vegetables constituted 73% of global exports of vegetables in terms of value. The corresponding figures for the developed and the developing market economies were 69% and 81%, respectively. In recent years the relative share of processed vegetables in total vegetable export has shown an increasing trend, both in the developed and developing regions (Table 4).

Table 4. Vegetable exports by commodity group.

Area/Country	Value of exports				Percentage of each commodity group in total exports				Share in world or regional exports			
	Unprocessed[z]		Processed[y]		Unprocessed[z]		Processed[y]		Unprocessed[z]		Processed[y]	
	1979-81	1983-85	1979-81	1983-85	1979-81	1983-85	1979-81	1983-85	1979-81	1983-85	1979-81	1983-85
	(US$ million)				(%)				(%)			
World[x]	7,109.7	7,070.7	2,433.8	2,614.9	74.5	73.0	25.5	27.0	100.0	100.0	100.0	100.0
Developed market economies	4,808.6	4,610.9	1,951.4	2,036.1	71.1	69.4	28.9	30.6	67.6	65.2	80.2	77.9
Developing market economies	2,301.1	2,459.9	482.5	578.7	82.7	81.0	17.3	19.0	32.4	34.8	19.8	22.1
Far East[w]	1,035.1	1,123.1	687.9	642.5	60.1	63.6	39.9	36.4	100.0	100.0	100.0	100.0
Thailand	690.2	711.8	61.0	79.3	91.9	90.0	8.1	10.0	66.7	63.4	8.7	12.3
China, Taiwan	43.4	43.7	441.1	349.5	9.0	11.1	91.0	88.9	4.2	3.9	64.1	54.4
Korea, Rep. of	75.4	86.9	55.5	36.9	57.6	70.2	42.4	29.8	7.3	7.7	8.1	5.7
Hong Kong	30.0	32.5	66.8	89.0	31.0	26.7	69.0	73.3	2.9	2.9	9.7	17.8
India	36.3	63.2	11.9	12.7	75.3	83.3	24.7	16.7	3.5	5.6	1.7	2.0
Singapore	26.2	46.6	16.2	19.4	61.8	70.6	38.2	29.4	2.5	4.2	2.4	3.0
Indonesia	52.9	41.5	3.8	–	93.3	–	6.7	–	5.1	3.7	0.5	–
Malaysia	13.5	16.1	7.2	8.8	60.5	77.4	39.5	22.6	1.3	1.4	1.3	0.7

[z]Vegetables, fresh and simply preserved. [y]Vegetables, preserved and prepared. [x]Excluding centrally planned economies. [w]Including Taiwan, China. Sources: UN 1979-1985 and COA 1979-1985.

As mentioned before the total value of vegetable exports from the countries in the Far East registered a higher rate of growth than that of other regions in the period considered, and the rates of increase in both exports of unprocessed and processed vegetables were also greater than those of other regions. The relative share of processed vegetables in the total value of vegetable exports has also shown an upward trend since the beginning of the 1980s, reaching 21% in 1983-85.

When the vegetable export of Taiwan, China is added to the data of the Far Eastern developing market economies, processed vegetables occupy a higher percent share in total vegetable exports, i.e. 36% in 1983-85, because Taiwan, China is the second largest exporter of vegetables in the Far East and its exports consist mainly of processed ones. However, in the region including Taiwan, China, as a whole, the relative share of processed vegetables has shown a declining trend, as a relatively higher importance has been placed on exports of unprocessed vegetables in recent years.

The contribution of Taiwan, China to exports of processed vegetables in the region was 64% and 54% in 1979-81 and 1983-85, respectively, and was followed by Hong Kong with 10% and 18%, respectively. In Hong Kong, contrary to the recent trend in Taiwan, China, exports of processed vegetables have been acquiring more importance, perhaps as a reflection of the decreasing trend in vegetable production (Table 4).

As mentioned above, the countries in the region as a whole have stepped up their production and export of vegetables, and these increases in production and exports have been accompanied by the expansion of markets. The increase in per capita GNP and the progress of urbanization in these countries, middle-income countries in particular, have stimulated the exporting countries to further expand intraregional trade of vegetables. The progress in marketing and transporting technologies have also accelerated increases in exports to countries outside of the region. These infrastructural improvements are augmented by changes in the international market conditions, such as favorable fluctuation of exchange rate to exporters.

Currently, the major markets for vegetables produced in the Far East are Hong Kong and Singapore within the region. The United States and Japan are other notable importers of Far Eastern vegetables. Because of their geographical position and their relatively high income level, these four importing countries are likely to remain the major markets for vegetable exports from countries in the region. It should be also noted that other countries in the region, such as India, Indonesia and the Republic of Korea, have increased their vegetable imports, thereby gradually reducing the relative share of Hong Kong and Singapore in the Region.

Table 5 indicates that from 1974 to 1985 vegetable imports of the highly industrialized countries and the high-income oil exporters increased considerably and more importance has been given to vegetables in total agricultural imports in these countries. This increase in importance of vegetable imports is notable also in other nations. As shown in Table 5, the value of vegetable imports has more or less decreased in the first half of the 1980s, partly due to the downward tendency of import prices, which had moved upward in the latter half of the 1970s. Compared with this general trend, however, it can be said that the performance of vegetable imports in recent years in Japan, the United States and some other Asian countries, is fairly good. The total market size for vegetables in these countries is quite substantial, and indicates a further potentiality for imports.

The demand for vegetables in the importing countries is rising steadily with population growth and increase in income, especially in urban areas. In the urban areas of the developing countries, consumers with relatively higher incomes have begun to purchase most of their food items from supermarkets. They demand high quality products with proper packing and labelling and are prepared to pay a higher price for products of superior quality. Moreover, especially in the developed countries, increasing income makes it less attractive for farmers to continue growing vegetables which are relatively labor intensive. This factor likely has some effect on lowering domestic production of vegetables and on increasing imports.

The United States, with 11% of the world import market for vegetables in 1983-85, has imported a substantial amount of vegetables from Asian countries, such as Taiwan, China,

Table 5. Vegetable imports.[z]

Area/Country	1974-76 Total agricultural imports a	1974-76 Vegetable imports b	1974-76 b/a	1979-81 Total agricultural imports a	1979-81 Vegetable imports b	1979-81 b/a	1983-85 Total agricultural imports a	1983-85 Vegetable imports b	1983-85 b/a	Annual growth rate 79-81/74-76	Annual growth rate 83-85/79-81	Annual growth rate 83-85/74-76
	(US$ million)		(%)	(US$ million)		(%)	(US$ million)		(%)	(%)		
World[y]	118,199.0	(100.0)[w] 6,131.6	5.19	206,811.4	(100.0) 11,573.1	5.60	201,043.0	(100.0) 11,579.0	5.76	14.3	-0.7	7.3
Developed market economies	90,430.2	(83.8) 5,138.0	5.68	150,307.6	(78.1) 9,046.2	6.02	142,090.0	(80.1) 9,274.1	6.53	12.0	0.6	6.8
North America	14,067.8	(11.1) 682.7	4.85	22,648.3	(11.6) 1,346.3	5.94	24,690.0	(15.5) 1,800.3	7.29	14.5	7.5	11.4
USA	10,987.3	(6.3) 389.2	3.54	18,098.9	(7.3) 841.2	4.65	19,996.2	(10.8) 1,254.8	6.27	16.7	10.5	13.9
Western Europe	63,153.6	(67.4) 4,135.4	6.55	107,349.9	(61.5) 7,119.1	6.63	96,516.0	(57.3) 6,636.0	6.88	6.2	-1.7	5.4
Japan	11,301.2	(4.0) 243.8	2.16	17,474.2	(5.1) 589.3	3.37	17,481.8	(6.1) 701.9	4.01	19.3	4.4	12.5
Developing market economies	27,768.8	(6.2) 993.6	3.58	56,503.8	(21.8) 2,527.0	4.47	58,953.0	(19.9) 2,304.9	3.91	20.5	-2.3	9.8
Near East	7,522.3	(3.0) 186.7	2.48	17,597.1	(5.0) 576.9	3.28	20,996.1	(5.4) 628.6	2.99	25.3	2.2	14.4
Far East	8,908.9	(7.0) 430.6	4.83	15,720.0	(5.5) 637.9	4.06	17,117.2	(6.7) 782.0	4.57	8.2	5.2	6.9
Hong Kong	1,726.4	(24.9) 107.2	6.21	2,982.5	(39.5) 252.2	8.46	3,517.0	(37.2) 290.7	8.27	18.6	3.6	11.7
Singapore	907.1	(14.4) 62.2	6.86	1,921.4	(19.4) 123.5	6.42	2,450.2	(20.1) 157.1	6.41	14.7	6.2	10.8
Malaysia	705.9	(9.1) 39.0	5.52	1,310.8	(11.5) 73.3	5.59	1,535.8	(11.4) 88.9	5.79	13.4	4.9	9.6
Korea, Rep. of	1,326.5	–	–	3,457.2	(3.9) 25.2	0.73	3,243.8	(5.4) 42.0	1.29	–	13.6	–
Indonesia	736.2	5.2[x]	0.71	1,507.6	(2.3) 14.6	0.97	1,124.4	(2.8) 22.2	1.97	–	11.0	–

[z]SITC code 054 and 056. [y]Excluding centrally planned economies. [x]054 only [w]Figures in parentheses show the share of vegetable imports of each region and country as percentage of the world and regional total, respectively. Source: UN 1974-1985 and COA 1974-1985.

Hong Kong, the Republic of Korea, the Philippines, Thailand, etc. In the United States a very large percentage of consumer food sales, over 90%, is through national, regional or local supermarket chains. They usually do not import directly from foreign countries, but buy through importers and wholesalers. According to Neese and Lepers (1983), although a wide range of vegetables are imported into the United States where import duties are relatively low, they must meet the importers' product specifications such as the form of processing, packaging, etc. Importers are willing to enter into an agreement with any supplier, provided they ensure the quality of the products and the ability to supply the required volume of commodities at competitive prices.

The Japanese market is another important market for vegetables exported from the Far East. Not only because of its geographical position and relatively high level of per capita income, but also because of the fairly high costs of domestic supplies of vegetables and the enhanced value of the Japanese yen, Japan may further expand its market for exports from countries in the region. Compared with the United States market, the marketing system in Japan is more complex and imports into Japan are subjected to various forms of tariff and restrictions. At present most vegetables, both processed and unprocessed, produced in the region are not subject to quantative import restrictions, but some encounter import prohibition into Japan to avoid bacterial, chemical and insect contamination. Japanese importers and processing companies are willing to operate with exporters in the region and provide them with assistance and advice regarding how their products should be packed, labelled or processed to meet Japanese requirements. An analysis of the Japanese market situation for vegetables follows.

Japanese Market for Vegetables

Current Production and Import Situation

Production and consumption trends. In recent years agricultural production as a whole in Japan, in which rice production contributes greatly, has shown a stagnant trend. The 15-year restriction imposed on rice production due to oversupply has led to stagnation of rice production. Horticultural and livestock production, which registered a fairly high rate of growth in the 1960s, has also slowed down recently. The slackened demand for farm products has, of course, constrained an increase of output of these products. The relatively increased costs of production, especially labor costs, have forced farmers to pull out resources from labor-intensive farming or to convert their farming into more capital-intensive forms.

These circumstances have apparently been reflected in the changes in total area of various crops and in the percent share of each crop in the total planted area. As shown in Table 6, the relative importance of vegetables to the total agricultural production has advanced in terms of planted area as well as value of production. It may be noteworthy that areas under the so-called 'western' vegetables, such as lettuce, celery, cauliflower, etc., and other luxurious ones, like vegetable soybeans and melons, have expanded recently. In addition, some western-type vegetables, such as artichoke, chicory, leek, okra, squash, zucchini, etc., and Chinese vegetables have been rapidly introduced recently into the Japanese market, in the place of traditional vegetables such as radish and edible burdock.

Increase in vegetable imports. Although more importance has been given to vegetables in agricultural production in Japan in recent years, the increase in vegetable production has been moderate as a whole and the per capita consumption of vegetables has been rather sluggish. However, the quantum index of vegetable imports has increased in the last few years (Table 7). The increase in vegetable imports, needless to say, has resulted from the fact that total consumption has exceeded domestic production by a narrow margin, but it may be more significantly affected by the recent substitution of the 'western' vegetables for the traditional ones.

The self-sufficiency ratio of vegetables is high by nature. In Japan the self-sufficiency ratio of rice, hen eggs and vegetables has continued to be high, while other farm products began

Table 6. Changes in agricultural production in Japan.

Production	Agricultural production 1965	1975	1986	Annual growth rate[z] 1965-75	1975-86	1965-86
	(US$ million)			(%)		
Total	8,825.0[x]	30,474.7[w]	68,664.6[v]	1.7	0.8	1.2
Rice	2,519.4	11,670.0	22,820.3	0.6	-0.9	-0.2
Vegetables	1,038.8	4,939.3	12,502.9	2.1	0.9	1.5
Livestock	1,841.6	7,878.7	18,868.2	4.9	3.2	4.0
Veg./Total (%)	20.9	25.8	27.5			
Planted areas	('000 ha)			(%)		
Total	7,430	5,755	5,606	-2.5	-0.2	-1.3
Rice	3,255	2,764	2,156	-1.6	-2.2	-1.9
Vegetables	691	632	636	-0.9	0.1	-0.4
Western veg.[y]	4	18	32	15.5	5.4	10.1
Veg./Total (%)	9.3	11.0	11.3			
Wes. veg./Veg. (%)	0.6	2.8	5.0			

[z]Annual growth rate of production is calculated using the production indices 1980 = 100. [y]Includes lettuce, celery and cauliflower. [x]US$1.00 = 360 Japanese yen. [w]US$1.00 = 297 Japanese yen. [v]US$1.00 = 167 Japanese yen. Source: MOAFF 1965-1987.

Table 7. Production, import and consumption of vegetables in Japan.[z]

Item	1975	1980	1981	1982	1983	1984	1985	1986
Production	94.0	100.0	101.8	102.7	99.9	102.1	101.3	103.6
Imports	49.4	100.0	114.5	103.9	114.1	137.1	132.9	146.4
Consumption, total	94.8	100.0	101.4	102.1	98.8	101.9	101.5	103.5
Consumption per capita	99.2	100.0	100.7	101.5	97.5	100.0	98.2	99.5
Self-sufficiency ratio (%)	99	97	97	96	96	95	95	95

[z]Indices (1980 = 100). Source: MOAFF 1975-1987.

to reduce their self-sufficiency ratio in the 1960s. According to the latest issue of Food Balance Sheets (MOAFF 1987), the self-sufficiency ratio of vegetables was 95% in 1986 which means that the quantity of vegetables imported still occupies just a minor part of total consumption. However, the high rate of increase in vegetable imports in the past few years may suggest the high import potential of vegetables as well as other food products.

In the last seven years, total agricultural imports increased at an annual rate of 5.0%, against a 4.6% increase registered by total imports into Japan. Compared with the 4.2% growth of agricultural imports during the 1970s, total agricultural imports advanced more rapidly in the 1980s. Although vegetable imports occupy a minor part of total agricultural imports, it should be noted that vegetable growth rates have exceeded total agricultural imports, together with confectionary, coffee, tea, fruits, meat and some food preparations, in recent years (Table 8).

At present agricultural imports are mainly cereals, meats, vegetable oils, confectionary, coffee, tea, fruits, vegetables, food preparations and beverages. Most of these commodities are consumer goods and cover more than 60% of total agricultural imports in terms of value, while in the mid-1970s more than 70% of total agricultural imports were occupied by such commodities as cereals, vegetable oils and raw materials like raw sugar, cotton, wool, hides and skins.

The rapid increase in imports of these consumer goods mentioned above has been supported by a rise in income levels and a relative decline in transportation and processing costs due to technological innovations. While a rise in income levels may enrich dietary contents, technological improvements of cookery and processing may diversify the diet and increase culinary pleasure, and technological progress in production and transportation may also expand the potentiality of importing perishable foods. In addition to these changes in circumstances related to the dietary

Table 8. Quantum indexes of agricultural imports.[z]

Agricultural production	1970	1975	1980	1981	1982	1983	1984	1985	1986	1987
Total	66.4	78.1	100.0	101.8	104.5	108.9	114.2	115.4	125.7	140.8
Cereals	63.7	78.6	100.0	100.5	100.9	103.7	110.7	107.5	109.9	113.3
Fruits	52.0	71.6	100.0	103.8	106.0	106.2	116.1	119.8	146.7	157.2
Vegetables	32.5	49.4	100.0	114.5	103.9	114.1	137.1	132.9	146.4	164.2
Sugar	130.7	106.8	100.0	72.2	97.1	84.5	85.8	90.0	83.7	82.0
Fancy foods[y]	55.1	76.7	100.0	107.7	111.8	117.7	127.0	132.9	144.8	164.2
Meat	31.2	77.5	100.0	126.1	114.7	125.5	136.8	138.9	162.9	196.3
Other food preparations and beverages	16.2	56.5	100.0	97.4	105.8	112.4	112.5	111.9	126.1	157.6

[z]Indices (1980 = 100) [y]Confections, coffee, tea Source: MOAFF 1970-1987

life, the rapid increase in the value of the Japanese yen since September 1985 and the strong requests to open the Japanese market to imported consumer goods have accelerated the import of agricultural products, including vegetables.

Causes and Effects of Increased Imports

Causes of increased import. It is natural that a shortage in domestic supply is met through imports when domestic supplies can not meet the demand. In Japan the production of raw materials, such as feed grains and oilseeds, is rather limited due mainly to the natural conditions; therefore these commodities have constituted a major part of agricultural imports. However, the increased and diversified import of agricultural products in recent years suggests that various kinds of agricultural products have been brought into the Japanese market not only to supplement the shortage of domestic supplies but also to meet the new types of demands for farm products.

One of the new types of demand is a call for high quality or scarcity value. These kind of demands have given an impetus to diversification through importation of small quantities of many items. Another type of import is characterized by the substitution of less expensive materials in place of the relatively expensive ones supplied domestically for restaurants, catering services and food-processing businesses. This type of import is represented by the rapidly increased import of frozen potatoes, poultry meats, etc., generated by the increase in eating out and in demands for processed foods.

Now, even some of the so-called 'traditional' foods of Japan are being imported. Imports now are not only to supplement the shortages but are open to a wide range of vegetable commodities. As long as profitability can be assured, any kind of vegetable commodity on the globe can actively be utilized in order to enrich the dietary life. In the 1960s and 1970s, imports of livestock products increased rapidly. Following these commodities, the import of vegetables, for which necessary resources are considered to be available in Japan, have accelerated in recent years and are expected to maintain an upward trend.

Imported vegetables are classified into five categories, i.e fresh, frozen, prepared and processed, preserved, and dried. Among these categories the import of frozen and prepared vegetables has shown the highest rate of growth both in terms of value and volume. Formerly, most vegetables imported were relatively preservable or for processing purposes, like onion. However, as the technologies have progressed in the fields of transportation, preservation and freezing, various vegetables, fresh, frozen and simply prepared (e.g, squash, carrot and cabbage), have gained a more important place in total vegetable imports.

Fresh vegetables, by nature, are imported to meet the shortage in supply and to reduce off-season high prices and take advantage of the geographical location of the exporter. Imports from Taiwan, China have fulfilled, and are fulfilling, such a function, as shown in Tables 9 and 10, but some types of vegetables such as squash, have recently been imported from Mexico and

Table 9. Commodities received from Taiwan, China at the Tokyo central wholesale market, 1983-86.

Year	Carrot (March-July)		Cabbage (January-March)	
	Average wholesale price	Quantity received	Average wholesale price	Quantity received
	(US$/kg)	(t)	(US$/kg)	(t)
1983	0.46[z]	–	0.26	1
1984	0.75[y]	355	0.71	1,974
1985	0.38[x]	–	0.21	8
1986	1.01[w]	1,400	0.69	1,341

[z]US$1.00 = 237.4 Japanese yen. [y]US$1.00 = 237.2 Japanese yen. [x]US$1.00 = 236.7 Japanese yen. [w]US$1.00 = 167.5 Japanese yen. Source: TCWM 1986

Table 10. Volume of goods arrived at Tokyo central wholesale market by month, 1986.

Month	Vegetable soybeans		Field pea	
	Total	Taiwan	Total	Taiwan
	(t)		(t)	
January	12	1	899	537
February	9	–	1,118	575
March	22	1	1,212	262
April	131	61	1,133	29
May	485	266	1,066	–
June	1,025	119	1,119	–
July	3,181	–	393	–
August	2,838	–	161	–
September	2,060	–	200	–
October	267	–	275	–
November	20	5	488	14
December	22	4	989	330
Total	10,072	457	9,053	1,747

Source: TCWM 1986.

New Zealand, taking advantage of the difference in harvesting season between the importing and exporting countries to meet off-season demands.

At present most of the fresh vegetables are available all year round owing to the development of glass-culture. However, the cost of the supply of summer crops in the winter season, mainly fuel costs, is generally high. Accordingly, as transportation technology has progressed, this supply has been substituted by importation, which takes advantage of the difference in harvesting seasons. In recent years, moreover, the profitability of vegetable imports, compared with that of glass-culture, has become greater because of the increased value of the Japanese yen. Table 11 illustrates this situation.

Year-round consumption, which has become feasible by the development of glass-culture and the relative decline in importing costs, has resulted not only in an increase in demand for various vegetables during the off-season, but also in the introduction of new types of vegetables which substitute traditional ones.

The rapid increase in imports of frozen vegetables in recent years has been induced by the remarkable expansion of the consumption of frozen foods, coupled with the relative decline in importing costs and the development of freezing techniques. Good examples of this phenomenon are vegetable soybeans and garden peas imported from Taiwan, China.

Other frozen vegetables, such as mixed vegetables, bamboo shoots, asparagus and potatoes, are used in restaurants and other food dispensing businesses in place of fresh vegetables supplied

Table 11. Volume of squash arrived at Tokyo central wholesale market by origin.

Volume arrived	1976	1981	1986
		(t)	
Total (a)	18,283	24,907	33,921
Jan.-April (b)	881	3,769	7,566
b/a (%)	4.8	15.1	22.3
Volume arrived by origin		(%)	
Mexico	0.6	3.6	44.8
New Zealand	–	19.9	31.9
Okinawa, Japan	0.8	61.0	10.2
Kagoshima, Japan	7.9	3.5	5.1
Miyazaki, Japan	79.3	8.0	4.1

Source: TCWM 1976-1986.

domestically because of their relative inexpensiveness. Frozen potatoes, imported from the United States, have led imports of frozen vegetables lately.

According to the results of the Household Survey, the percent share of expenditures for dining-out in total food expenditures per household in 1986 was 15% against 10% in 1975. And total volume of sales in the so-called 'eating-out' industry (restaurants and other food dispensing businesses) in 1986 was estimated at about US$92 billion, more than twofold that of 1975. This exceeded the total sales of the steel industry.

Such an expansion of the eating-out industry, coupled with the increase in demand for processed foods has provided larger markets for frozen and simply prepared vegetables imported from abroad. Moreover, the importing business of these commodities from the Far East, including Taiwan, China, has become more profitable recently because of the higher value of the yen, compared with the high costs of materials produced domestically and of Japanese labor. Such an economic situation has given impetus to the increased import of these commodities.

Effects of increased imports. The relative share of vegetables imported from abroad is only 5% at present. Most of them are used mainly to supplement the shortage in domestic supplies and sometimes for their scarcity value. It may be said, however, that the increase in imports will generate new demand for vegetables, including new types of vegetables and will result in the expansion of the domestic market for vegetables. The increased imports may also bring about changes in the patterns and the structure of domestic production through competition in the market between domestic vegetables and imported ones.

In recent years the relative share of imported vegetables to total sales of vegetables in the supermarkets has apparently expanded, the consumption of imported vegetables in restaurants and other food dispensing businesses has advanced remarkably, as well as that of the food processing industry. Since the increase in consumption of imported vegetables reduces material costs for these enterprises, they are eager to bring in more such imports. Accordingly, contract vegetable growing with Japanese traders and other enterprises, like food processing companies, is expected to increase.

These import contracts, which are fairly common in Taiwan, China at present, are accompanied by technical guidance and assistance extended by these enterprises. The indications are generally that this kind of contract farming is to be extended through several countries in the region. It is supposed that recent changes in economic circumstances, such as an increasing trend of labor costs in Taiwan, China and the active introduction of foreign capital into certain countries, may accelerate changes in the location of production for export to Japan.

Thus, the strong demand for imported vegetables in Japan may provide an increased incentive for higher production of vegetables in the region. It should be considered, however, that expansion of domestic markets of each country is necessary to increase and stabilize supplies. Improvements in marketing systems and techniques are also required.

At present, Japanese importers provide preimport assistance to exporters on the desirable standards and quality of commodities. Consequently, these vegetables exported from countries in the region are more competitive than Japanese products in terms of price.

Some countries in the region are now faced with the tasks of diversifying agricultural production and of raising productivity and income from agriculture. The United States, Japan and other developed countries, as well as some newly industrializing ones, will possibly provide greater markets for vegetables produced in the region. Considering the present situation of farming and marketing of vegetables in the region, more investments in research and development of vegetable farming and marketing in the region may be beneficial.

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Improving Technology of Vegetable Production in Southeast Asia

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Introduction

This report provides an assessment of the impact of the ADB-funded bilateral programs of the Asian Vegetable Research and Development Center (AVRDC) in Indonesia, Malaysia, the Philippines and Thailand. There seems to be general agreement among policy makers, educators, scientists and the public that as a group vegetable crops have great potential for improving the lives of people in developing countries, particularly the small farmer and the rural poor. Vegetables constitute the richest source of vitamins, minerals and plant proteins and thus if eaten, especially by children in the rural areas, could alleviate the most serious malnutrition problems such as vitamin A, B, and D deficiencies. More widespread cultivation of vegetables could generate rural employment since most vegetable crops are labor intensive and stimulate urban employment as well as because of the increased requirement for manufactured inputs such as fertilizers, pesticides, sprayers and many other items. Moreover, foreign exchange earnings may increase through vegetable export and may raise the incomes of small farmers who can utilize improved technology in their farming systems.

The Memorandum of Understanding for the establishment of AVRDC and the Charter of the Center were signed by the sponsors (Japan, the Republic of Korea, the Philippines, Thailand, USA, Vietnam, The Republic of China and the Asian Development Bank) in 1971. As stated in the Charter (AVRDC 1984) "The Center shall pursue any and/or all of the following objectives pertaining to vegetable research and development:

1. To conduct research on production and marketing programs and to assist participating countries in developing their own adaptive research programs;
2. To carry out training in production and marketing programs, and to assist participating countries in developing more efficient training and marketing programs; and
3. To develop and provide basic information on improved production and marketing for use by extension services in participating countries."

AVRDC and CIP are the only international agriculture research centers (IARCs) engaged solely in improving the production and quality of vegetables. Initially, research at the Center concentrated on six crops: i.e. mungbean, soybean, tomato, sweet potato, white potato and Chinese cabbage. In 1976 white potato was dropped from the list of principal crops because the basic objective of developing heat tolerant germplasm had been reached, and another IARC conducted research on this crop. Pepper was added as a principal crop in 1986. AVRDC also undertakes evaluation of yield and other horticultural characteristics of commercially available varieties (i.e. cauliflower, mustard green, raddish and snap beans) under tropical environments.

AVRDC functions under the same guiding principle as the other IARCs. It follows an interdisciplinary approach towards the resolution of key crop problems since problems besetting crop production are never simple and always encompass several well-defined disciplines.

The Center has been improving the technology of vegetable production for the hot, humid tropics since its initiation in 1972 (Opeña 1988). Many countries in the tropics and subtropics,

particularly those in Southeast Asia, have relied on AVRDC's improved technology. Any new technology generated through AVRDC research is shared with the national programs for further development, adoption, and utilization through a number of mechanisms: informal collaboration (i.e. scientist to scientist arrangements), training programs, information dissemination, symposia and workshops, staff travels, collaborative germplasm evaluation, research working groups, consultancies and bilateral programs. The Center also has been training personnel of the national programs who ultimately train other technicians within the national programs.

The Asian Development Bank has been assisting AVRDC in attaining its objectives. The Bank's first technical assistance to an IARC was to AVRDC in 1969 to help finance the establishment of the Center and the development of its experimental farm. The Bank also provided technical assistance to AVRDC which permitted the Center to establish bilateral agreements with the following governments of Southeast Asia:

1. Outreach Programs in Vegetable Research in the Republic of Korea, the Philippines and Thailand, (T.A. No. 5027, approved on 11 April 1975);
2. Strengthening Vegetable Research in Indonesia and Malaysia (T.A. No. 5119, approved on 15 February 1983);
3. Regional Training Program in Vegetable Production and Research (T.A. No. 5143, approved on 20 December 1983); and
4. Regional Training Program in Vegetable Production and Research, Phase II (T.A. No. 5253, approved on 18 June 1987).

The Asian Development Bank has recently granted AVRDC another technical assistance for a planning and organization workshop to establish a Collaborative Vegetable Research Program in Southeast Asia (Anonymous 1988a). This grant will enable AVRDC to conduct a workshop aimed at discussing the current status and priorities for vegetable research in Southeast Asia and an opportunity for ADB to review its support to AVRDC for the last two decades.

The primary objectives of this paper are clearly defined in the terms of reference provided below. "More specifically, the consultant is expected to undertake an assessment of the impact of the ADB-funded bilateral programs of AVRDC in Indonesia, Malaysia, the Philippines and Thailand. The various tasks to be carried out include the following:

i. Assess the appropriateness of the bilateral program approach for the transfer of new technology from AVRDC to the respective National Agricultural Research System (NARS);
ii. Determine the institutional relationships which facilitate the bilateral working arrangements and document the experiences of the respective NARS;
iii. Assess the impacts of the bilateral programs on the dissemination and generation of technology in the NARS, such as for instance, on varietal improvement;
iv. Assess the contribution of the bilateral programs in the generation of knowledge, i.e. publications, seminars, symposia, workshops, etc.;
v. Assess the importance of the bilateral programs on training vegetable research scientists in the NARS and comment on the impact of training;
vi. Assess, as far as possible, the impact of the adoption of new technology generated through the bilateral programs in the respective NARS including possible residual effects which have indirect but qualifiable impacts such as improvement in the general quality of research, more efficient utilization of resources through better investigative techniques, multi-disciplinary approach to problem solving, inputs into the vegetable industry, etc.;
vii. Comment, as far as possible, on the appropriateness of the new technology generated through the bilateral programs, especially on the production input requirements and output effects (increased yield, improved quality, better uniformity, etc.);
viii. Comment on the contribution of the bilateral vegetable programs in generating savings in foreign exchange, amelioration of human nutrition, creating employment, improving farm income, changing the distribution of income, and increasing the income of small farmers;

ix. Prepare a comprehensive report incorporating the experiences of the respective NARS through the bilateral programs of AVRDC and suggesting appropriate approaches in the future to effectively assist the vegetable research in developing countries; and
x. Present the results of the research assessment survey during the workshop on collaborative research in SE Asia to be held at AVRDC from 1-5 August 1988."

Methodology

The Consultative Group for International Agricultural Research (CGIAR) commissioned several persons to conduct an assessment of the CGIAR system to National Agricultural Research Systems in a number of developing countries (Nestel 1985, Gomez 1986, Isarangkura 1986). In all these studies, the methods consisted of mailed-questionnaires, interviews with selected persons and use of secondary data or a combination of the three. In this study the consultant employed all of the above methods but with some modifications to insure a larger number of respondents, particularly in the interview and questionnaire portions of the study.

Questionnaire

A four-page questionnaire was mailed to as many AVRDC alumni residing outside Los Baños as possible, hoping that a 50% response would be achieved. For those residing in the Los Baños area, the questionnaires were personally delivered. Enclosed with the questionnaire was a cover letter signed by the consultant which explained the purpose of the questionnaire, the urgency of the study and an appeal for cooperation. In the case of Thailand, Malaysia and Indonesia, key individuals were identified to whom the questionnaires were sent for redistribution to AVRDC alumni in those countries. As a precautionary measure, the cover letter and questionnaire were photocopied and sent to at least two others in the same general location. This method worked very well for Bangkok, Chiangmai, Kuala Lumpur, Bogor and Lembang where there are a concentration of alumni. In a number of cases, the consultant followed up the questionnaire with a telegram.

Interviews

Personal interviews with administrators, policymakers and crop scientists who had been involved in the activities of AVRDC were conducted rather than sending questionnaires, considering that they would generally be too busy to fill in the questionnaires. Moreover, there could be no better substitute for such personal interaction with this sector. The interviews were similarly conducted with a number of alumni in order to obtain an elaboration of their responses and thus gain deeper insight to their problems and suggestions. Some IARC scientists and administrators, and expatriate consultants were also interviewed to obtain their views on international agriculture and networking.

Secondary Data

The Bank, AVRDC, and the authorities from the four countries willingly provided the consultant with available documents relevant to this study. In many occasions, however, reliable data were not readily available in which case several sources had to be sought to verify information.

The ADB-Funded Bilateral Programs

The Bank has played a leading role in the establishment of AVRDC and in supporting its outreach programs in Southeast Asia. The Bank provided technical assistance which permitted

AVRDC to establish bilateral agreements with the governments of the Philippines, Thailand, Malaysia, Indonesia and the Republic of Korea in order to facilitate the movement of AVRDC's new technology to the national programs of the aforementioned countries (Anonymous 1975, 1983, 1984a). The main objectives of these agreements were:

i. To test in these host countries the new varieties and production techniques of vegetables developed at AVRDC;
ii. To determine the best varieties and cultural practices suited to local conditions and requirements; and
iii. To multiply and distribute to local farmers the varieties so selected.

In general, the Project included provisions for:

i. The establishment and development of an Outreach Center for carrying out the Project;
ii. The appointment of an expatriate Resident Scientist for a period of two years to establish and operate the Outreach Program and to coordinate the work of the Outreach Center with AVRDC;
iii. The training of local technical personnel at AVRDC;
iv. The supporting services by AVRDC, including periodic visits by specialists called Visiting Specialists); and
v. The procurement of equipment, machinery and supplies required for the Project.

The supporting services to be provided by AVRDC included:

i. Services, through periodic visits, of such Specialists as shall be necessary for the successful carrying out of the Project;
ii. Planting materials and research data on a sustained basis; and
iii. Recommended cultural practices and necessary experimental chemicals.

The Center shall also recruit and employ the resident scientist and develop his terms of reference in consultation with the host government and ADB; shall make arrangements and provide facilities for the training of local personnel and provide assistance to the Government in the utilization of Bank funds.

The host governments, on the other hand, are generally committed to provide infrastructure, research personnel and administrative and support staff for the operation of the Project. They shall ensure also the following:

i. Personnel trained under this technical assistance will be utilized in appropriate positions relating to vegetable research and production with the objective of ensuring the continuous operation of the outreach programs. The Bank will be kept informed;
ii. Procurement of equipment will be undertaken in accordance with international shopping procedures, except for items to be matched with existing equipment;
iii. The outreach programs will be continued beyond the two-year period covered by the Project and will be extended into additional vegetable growing areas;
iv. Seeds and planting materials of varieties proven in the outreach program will be multiplied and supplied to farmers at reasonable prices; the Bank will be kept informed;
v. Research results obtained by the Outreach Centers will be documented and published; and
vi. Quarterly progress reports relating to the activities of the outreach program will be provided to the Bank."

Philippine Outreach Program

The first bilateral agreement implemented was the Philippine Outreach Program (POP) in Vegetable Crops (Anonymous 1975). The agreement was signed on 24 June 1975 and operated

until June 1977. The Project consisted of the establishment and operation by the Philippine Government of an outreach program for vegetable research and production in the country with the objectives presented earlier. The Department of Agriculture was designated the lead agency with the Bureau of Plant Industry (BPI), Economic Garden at Los Baños, Laguna as the principal site.

The AVRDC/POP has undergone three distinct phases of development (Legaspi 1986 and Palo 1988): Phase I - under the ADB Assistance (1975-77); Phase II - under the PCARRD Systems (1978-83) and Phase III - under the ASSP/PCARRD Project (1983 to date).

Under Phase I a resident scientist was recruited by AVRDC and posted at the BPI Economic Garden with a general terms of reference as expressed in the objective of the project presented earlier.

The relationship of the Resident Scientist with the staff of BPI is shown in Figure 1. The Resident Scientist reported directly to the AVRDC Director but coordinated any local activity with the BPI Director who provided him with limited funds to undertake variety trials and other experiments. Administratively, the Resident Scientist had only one clerk typist assigned to him but when needed any researcher could be temporarily assigned to him. This scheme posed some problems because the researchers were responsible to the Superintendent and not to the Resident Scientist. The Resident Scientist could have acted as adviser to the BPI Director who in turn could have passed on the implementation of activities to his Regional Director down to the Superintendent and researchers. Another weakness of the system was the complete freedom of the Resident Scientist to do any activity even without consulting local authorities or coordinating with the BPI Director since his immediate superior was the AVRDC Director based at AVRDC. The Resident Scientist appeared to have worked independently of the national program instead of working with the national program.

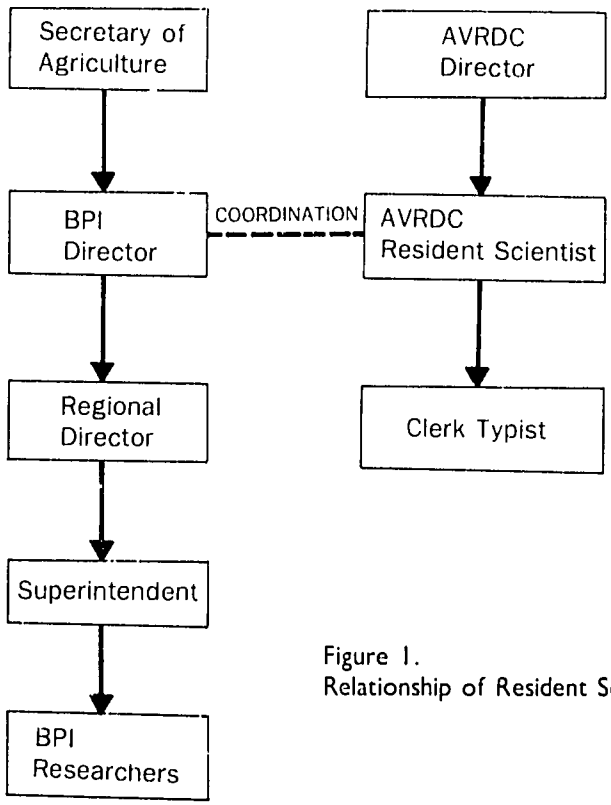

Figure 1.
Relationship of Resident Scientist in POP with the staff of BPI.

Nevertheless, much was accomplished during Phase I (Legaspi 1988). Among these notable accomplishments were: the adoption of recruitment procedures for selection of training fellows (Anonymous undated a). The early establishment of such procedures minimized, to a large extent, the professional jealousies among fellowship competitors and their major backers. Thus, the training of technical personnel of POP and other organizations which conducted research on vegetable crops were undertaken at AVRDC without too many complaints from the ranks. The Resident Scientist strengthened contacts with research workers in state colleges and universities (SCUs), and other government and private institutions. Many evaluation trials on the AVRDC crops were carried out under Phase I, mainly at POP and other centers such as the University of the Philippines at Los Baños (UPLB), Central Luzon State University and Mindanao State University. Most experiments dealt with the testing of accessions, advanced breeding lines and evaluation for resistance to pests and diseases.

Whatever misunderstandings and problems that ensued between the Resident Scientist and local researchers were forgotten as soon as the two-year contract of the Resident Scientist expired and he left the country. The responsibility for running AVRDC/POP then was transferred to a local scientist.

In compliance with the technical agreement with AVRDC and the Bank, the Philippine Government, through PCARRD, continued the project upon termination of the two-year assistance agreement. In 1978 PCARRD approved the incorporation of AVRDC/POP in the national research system as PARRS Project 722 entitled "Testing of AVRDC Vegetable Varieties in the Philippines" for a period of five years from 1978 to 1983 (Palo 1988).

A local scientist was appointed project coordinator who managed the AVRDC/POP and participated at the annual program review at AVRDC where he also reported on POP activities, new plans and programs of the outreach center.

The organizational chart of AVRDC/POP under the PCARRD system clearly shows the implementation path of the testing program (Figure 2). The cooperating scientist detailed to the project in each of the stations reported to the deputy for operations who in turn reported to the project manager who was answerable to the regional director. The regional director reported to the BPI Director. This scheme provided more coordination and more regular funding than the previous organization since the allocation was incorporated in the regular budget of PCARRD.

In addition to the BPI Economic Garden as the outreach center, four other stations served as satellite stations of POP, namely: Bicol Experiment Station in Camarines Sur, La Granja Experiment Station in Negros Occidental; Eastern Visayas Experiment Station in Leyte and Misamis Oriental Horticultural Research Center in Misamis Oriental.

The national scheme for varietal development was followed for all AVRDC crops (Figure 3). Essentially the promising selections were field evaluated in a series of trials. First, they were evaluated under the preliminary yield trial (PYT) at the POP center in both wet and dry seasons. Second, those lines that outperformed the standard checks were further tested under the general yield trial (GYT) in five cooperating stations. Finally, those selections which proved superior in the GYT were entered into the national cooperative test (NCT) for evaluation under the regional yield trial (RYT) before they were released for national recommendation.

The five-year operation of AVRDC-POP under the PCARRD system was modified in 1983 when its operation was integrated into PCARRD's research system. At that time funding was jointly provided by the BPI Research Division and the ASSP/PCARRD Project. Another coordinator was designated to supervise and monitor POP. Because of limited funds, all trials were undertaken at the outreach center in Los Baños following the national scheme on varietal development. However, cooperative trials in farmers' fields have been strengthened to verify and augment results obtained at the station.

Issues Raised During Interviews

A number of issues were raised by several persons interviewed in the Philippines.

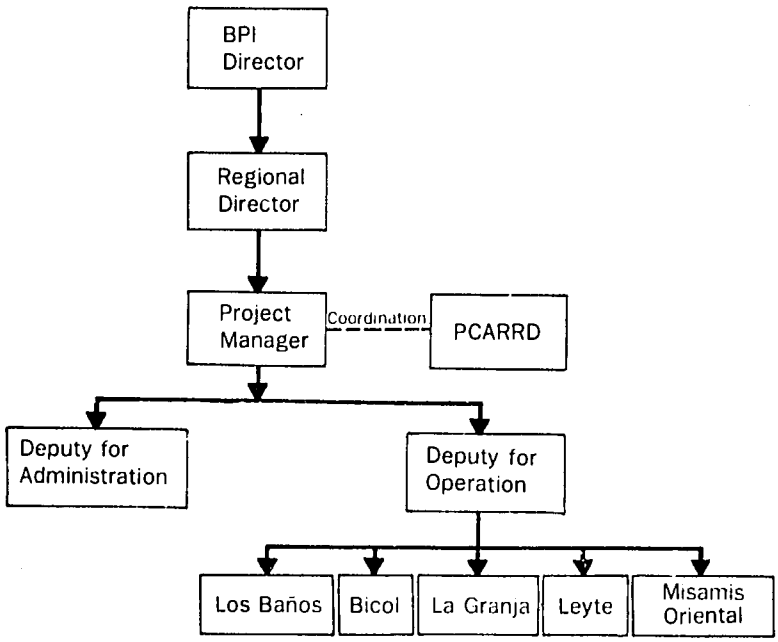

Figure 2. Relationship of Project Manager to cooperating scientists under the PCARRD system.

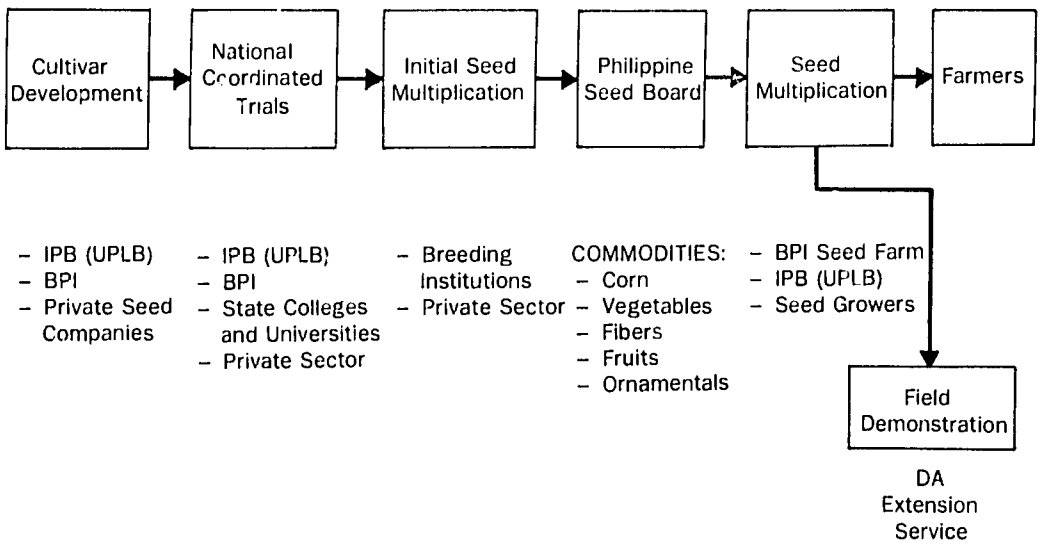

Figure 3. Cultivar release scheme in the Philippines (PCARR 1977).

Visits of AVRDC scientists. The very noticeably infrequent visits of AVRDC scientists to the national program has caught the attention of local scientists. Besides the infrequency, they often remained too short of a period for useful interaction with local scientists. This concern was repeatedly expressed in all four countries included in this study. It is, therefore, suggested that such visits be encouraged and so planned to coincide with local annual reviews and planning workshops and scientific conferences (i.e. annual meetings of the Federation of Crop Science Societies of the Philippines and the Pest Control Council of the Philippines).

Attendance at AVRDC annual review. Interest was expressed at the possibility of inviting more than one Filipino scientist to attend the Annual Progress and Planning Workshop at AVRDC. A number of Malaysian, Thai and Indonesian administrators also recommend this innovative practice. It is envisioned that institution of this practice will expose and provide more experience to members of the NARS.

Distribution of AVRDC breeding materials. The institution of better coordination in the distribution of AVRDC breeding materials to NARS was requested. A case in point was the usual practice of AVRDC to provide Filipino trainees and other AVRDC visitors with such materials without informing POP. This practice results in waste of time and efforts for all concerned since many of them neither plant the seeds nor provide AVRDC with feedback of the germplasm performance.

Coordination with other IARCs. In the case of legumes, better coordination with other international centers (i.e. IITA and INTSOY) is needed so that only selected institutions within the NARS which are capable of conducting the evaluation trials become recipients of seed materials for trials.

Thailand Outreach Program

Although T.A. 5027 establishing the Outreach Programs in Vegetable Crops for the Philippines, Korea and Thailand was signed on 11 April 1975, the Thailand Outreach Program (TOP) became operational only at the end of 1981 due to political difficulties (AVRDC 1984). The lead agency to implement the agreement was Kasetsart University with the operations carried out in its Kamphaeng Saen Campus located 100 km from Bangkok.

The TOP, like the POP, has undergone three phases (Anonymous 1984a and 1987, and Yang 1987): Phase I - Outreach Program in Vegetable Research (1981-83); Phase II - entitled Regional Training Program in Vegetable Production and Research (1983-86); and Phase III - with the same title as Phase II (1987-90). Like with POP, all of these phases have been supported by the Bank, except that the Government of Switzerland cofinanced Phases II and III. Phase I had similar objectives as presented at the beginning of this section. Phases II and III have expanded training facilities in vegetable production and research and adopted the following activities: (a) the Regional Training Program will include a five-month training course leading to a diploma to be awarded by the University. Such a training course consists of field activities, classwork and lectures covering plant breeding, plant physiology, crop management, plant pathology, entomology, agricultural chemistry, soil science, and field experimentation and (b) the Regional Training Program will include short-term training courses in specific aspects of vegetable production technology.

The Resident Scientist was recruited under Phase I and has continued to serve until the present with the following terms of reference (Anonymous undated b):

i. Establish a close working relationship between the AVRDC Outreach Program based in Thailand and other vegetable production countries;
ii. Expand training facilities in vegetable production and research for the aforementioned countries as appropriate;
iii. Set up the mechanism for and organize in-country workshops in selected Asian countries (initially in countries that already have existing bilateral research aggreements with AVRDC, namely Indonesia, Malaysia, the Philippines and Thailand);
iv. Provide advisory support for the vegetable research program in Thailand;
v. Upgrade national vegetable research programs in Thailand and other countries by providing training programs in vegetable research and production at the Kamphaeng Saen site;

vi. Ensure in these training programs that the technological advances made at AVRDC are taught to the trainees and thus become transferred to their respective countries;
vii. Present course work in his own field of specialty and coordinate the presentations by other subject matter specialists;
viii. Organize, according to needs, specific training courses/workshops on such aspects as hybridization technology, home-garden programs, seed technology, crop protection, etc.
ix. Prepare semiannual progress reports for consideration by the Government of Thailand, AVRDC and the Bank.

These above-mentioned terms of reference are for Phase II and III; the terms of reference for Phase I appeared not to be documented.

Under this Agreement the Thai Government is committed to provide the following:

i. Twelve (12) hectares of land at the Kamphaeng Saen campus of the University suitable for experimental purposes for vegetable production and research;
ii. Suitably furnished and equipped laboratory, screen house, green house and office accomodation, including maintenance and the cost of utilities;
iii. Such classroom, dormitory and library facilities as may be required for the purposes of the proper conduct of the Regional Training Program;
iv. Such laboratory and office supplies, secretarial assistance and reproduction and communication facilities as the Resident Scientist and the Specialists shall reasonably require for the purposes of the Regional Training Program;
v. Such vehicles (including drivers and the cost of maintenance and operation) and such other internal transportation facilities as the Resident Scientist and the Specialists shall reasonably require for the purposes of the Regional Training Program;
vi. Such operational devices, apparatus, instruments and equipment (including agricultural machinery and farm equipment) and other data and information as may be required by the Resident Scientist and the Specialists for the successful conduct of the Regional Training Program; and
vii. Suitably furnished living accommodation including the cost and maintenance of utilities (electricity, gas and water services) for the Resident Scientist and his family.

The host government prepared for the smooth implementation of the Outreach Program. In fact, the Minister of University Affairs, as early as 1 December 1981, signed a memorandum appointing a Policy Board consisting of 13 members drawn from the Department of Agriculture, the Department of Agricultural Extension, the Science Council, the National Economic and Social Development Board (NESDB), the Budget Bureau, Khon Kaen University, Chiangmai University, Prince of Songkhla University and Kasetsart University with the Rector of Kasetsart University as chairman and his Vice-rector as secretary (Anonymous 1981). The Board has the following responsibilities:

i. To fulfil the obligations as specified in the Technical Assistance Agreement between the Government of Thailand-AVRDC-ADB, e.g. having the activity center established at Kamphaeng Saen campus of Kasetsart University and working on five mandated crops: tomato, Chinese cabbage, sweet potato, soybean and mungbean;
ii. To develop policy on vegetable development in line with the policy of AVRDC and in conformance with the national policy on vegetables;
iii. To set guidelines for yearly activities of TOP to include works on research, extension and training for the transfer of technical know-how in vegetable production to farmers;
iv. To coordinate between AVRDC and government agencies working on vegetables with respect to technical information, training and germplasm; and
v. To provide assistance and cooperation with other government agencies working on research, development, extension and training on vegetable production for the farmers.

The Policy Board, in turn, created an Implementing Committee to perform the following activities:

i. To work out details of the activities according to the guidelines adopted by the Policy Board;
ii. To set up subcommittees as deemed necessary;
iii. To evaluate the activities carried out and present reports to the Policy Board;
iv. To take responsibility in the allocation of the Thai budget for the Thailand Outreach Programs; and
v. To prepare the annual budget proposal for the Thailand Outreach Programs.

The relationship of the TOP Director/Resident Scientist with Thai officials and scientists is presented in Figure 4. As presented in the terms of reference of the Resident Scientist, he is "to provide advisory support for the vegetable research program in Thailand" and his link is directly with the Policy Board with one of its functions "to coordinate between AVRDC and government agencies working on vegetables with respect to technical information, training and germplasm." Theoretically, therefore, the Resident Scientist is advisory to the Policy Board and any implementation of TOP-approved activities should be implemented by its Implementing Committee through its coordinator and Thai scientists who may be attached to the University or other Thai government institutions.

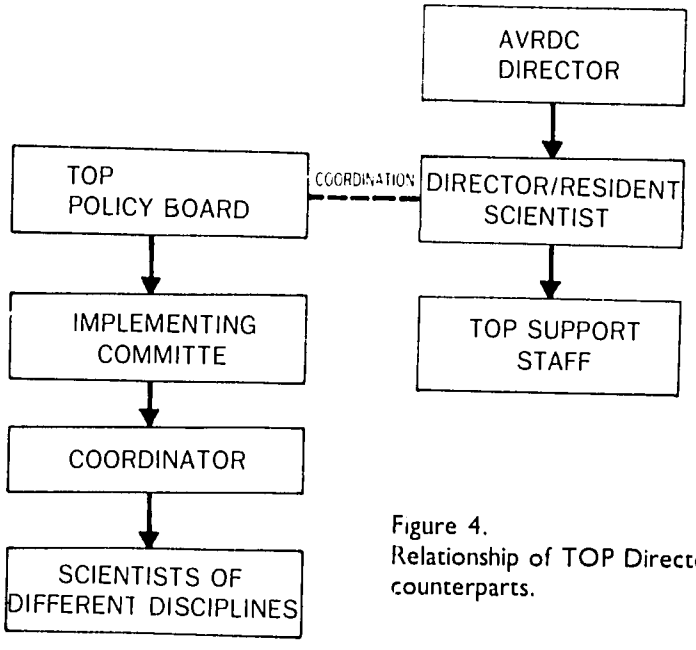

Figure 4.
Relationship of TOP Director/Resident Scientist with Thai counterparts.

A number of accomplishments have been reported by the Resident Scientist during Phase I such as: establishment of TOP offices at Bangkhen and Kamphaeng Saen Campus of Kasetsart University which facilitated both business transactions and activities of TOP (Yang undated). The 12-ha experimental field and a nursery for raising seedlings were developed in addition to the construction and remodelling of other facilities at the Kamphaeng Saen Campus. These permitted experiments on various aspects of vegetable research (i.e. evaluation of AVRDC materials and cultural practices) to be carried out on a year-round basis. The Resident Scientist coordinated also with the national agricultural institutions and helped to select Thai staff for various training courses at AVRDC. Among the accomplishments under Phase II were (Yang

1987): continuation and intensification of improving the station, research and training activities in Phase I (i.e. expansion of field research programs to Chiangmai, Khon Kaen, Nong Kai, Burirum, Songkla and Narathiwat; establishment of a network with Thai Government Agricultural Extension Agencies to facilitate the transfer of TOP-AVRDC varieties and technology into Thai national programs; coordination of the movement of AVRDC breeding materials and other germplasm to countries in the region such as Bangladesh, Burma, Cambodia, China, Laos, Nepal, Pakistan, Sri Lanka and Vietnam; conducting a five-month training course in vegetable production and research to accommodate trainees mostly from the aforementioned countries; and cosponsorship of workshops/symposia like the Chinese Cabbage and Seed Production Workshop held in Khon Kaen in February 1984 and the Second International Mungbean Symposium held in Bangkok in November 1987.

Issues Raised During Interviews

Several issues were raised by those interviewed in Thailand.

The role of the Resident Scientist. It was evident from this study that his terms of reference from Phase I to Phase III were not known to the Thai officials within and outside the University, resulting in misunderstanding and confusion. The situation was further aggravated when the Resident Scientist stayed on even after the two-year Agreement under Phase I was terminated. A common complaint had been the frequent foreign travels of the Resident Scientist whom they claim should have been more visible in Thailand conducting research. Such misunderstandings could have been avoided had the parties involved elevated the status of TOP into a Regional Training Center for Vegetable Crops and correspondingly changed the title from resident scientist to regional coordinator starting with Phase II. In fact, his terms of reference clearly indicated that a higher percentage of his activities are indeed regional coordination in nature. It would have been ideal also if the terms of reference of the Resident Scientist had been made transparent so that everybody could have been aware of his expanded responsibilities.

Visit of AVRDC scientists. Although this issue is common to all countries, one factor that partly contributed to its worsening situation is the apparent lack of constant communication among the parties concerned. Consequently, even with the frequent visits of AVRDC scientists in Thailand, only a few of the local officials and scientists had a chance to take advantage of their presence.

Thailand as regional center. Although Phase II had been terminated and Phase III started in 1987, it seems that there is still resentment from a number of persons interviewed that Thailand "has been used by AVRDC as seed broker and training site" in order to accommodate countries which are not friendly to Taiwan, China. A question comes to mind at this point: Was there sufficient consultation or public hearing within the policymakers and scientific community before the said proposal was submitted to ADB for consideration?

Lead agency for the bilateral agreement. Despite the fact that TOP has been going on for almost seven years with Kasetsart University as the lead agency, there is still resentment in some quarters as to why this has happened. The rationale for selecting an academic institution over the Department of Agriculture to represent the Thai Government in the bilateral agreement should have been made clear to all concerned. Perhaps the resentment also could have been minimized, if not totally eliminated, if other institutions included on the Policy Board and Implementing Committee would have been more actively involved in the TOP's various activities rather than just attending meetings in the aforementioned bodies.

Strengthening Vegetable Research: Indonesia-AVRDC

The Technical Assistance Agreement (Strengthening Vegetable Research Project) dated 13 October 1983 was signed by the Government of the Republic of Indonesia, AVRDC and ADB

(Anonymous 1983). "The Project will support the efforts of the Agency for Agricultural Research and Development of the Government's Ministry of Agriculture to strengthen vegetable research and production in Indonesia." The objectives of the Project and provisions are similar to those in the Philippines and Thailand as presented earlier. One additional provision which was absent in all other Agreements, was "(vi) the organization of a regional workshop in Indonesia on vegetable research in Asia." AARD was the designated executing agency in the Agreement (AARD 1984). However, the actual implementation of the Project was carried out by the Lembang Horticultural Research Institute (LEHRI) through the Central Research Institute for Horticulture (CRIH) (Anonymous 1986b).

The original plan was not to engage a resident scientist but instead selected AVRDC scientists would be rotated every three months. However, the scheme encountered difficulties and was not carried out. Thus, a resident scientist was appointed and reported to Lembang at the end of April 1986 with the following responsibilities:

a. To assist and advise in breeding of vegetables, mainly tomato and Chinese cabbage. Also to accomplish variety trials in the effort to search for promising varieties;
b. To assist and advise in organizing the workshop/seminar of February 1987; and
c. To make a report by the end of the assignment concerning vegetable research in Indonesia.

The First Year and Final Reports clearly showed that the Project concentrated on tomatoes, Chinese cabbage, sweet pepper and sweet potato; there were no evaluation trials conducted for soybean or mungbean (Subijanto undated, Tonguthaisri 1987). Such trials were carried out by CRIH in its stations throughout Indonesia. The Project at Lembang notes the following accomplishments: the undertaking of several varietal trials and cultural management experiments; training of Indonesian scientists at AVRDC and consultation with AVRDC scientists who visited Indonesia during the duration of the Project.

Issues Raised During Interviews

The most significant issues raised during the interviews are listed below.

Coordination among donors. Although this issue was also expressed in other countries, it was more prominently ventilated in Indonesia. It appeared that the interest of donors of similar programs tend to duplicate and compete rather than complement activities resulting in inefficiencies in the use of their resources. Some donors even went to the extent of granting long-term training programs without looking at the on-going activities of the trainee, who did not have anyone to take care of his job while he was away. Naturally this arrangement disrupted other activities in which the trainee was engaged. Thus, more consultation and coordination are absolutely necessary to minimize duplication and ensure complementation of activities. For instance AVRDC and the Dutch Project ATA 395 for lowland vegetables can benefit greatly if they coordinate their activities on germplasm, low pressure irrigation, sex pheremones, IPM and many other items.

Discretion in the identification of contribution. In a few instances local scientists expressed resentment at the way AVRDC reports its contribution on variety releases because the report seems to diminish the role of cooperating scientists who experience great difficulties in the midst of low resource conditions. This issue is so sensitive that it can damage the professional kinship between AVRDC and some NARS scientists. The provision of credit where credit is due is the best manner to deal with this issue.

Communication among staff. It was unfortunate that the Project was known only to a few staff of the Institute. In fact, a number of staff did not even have the opportunity to interact with the Resident Scientist. It is essential that internal communication and interaction should be improved or instituted if absent. The lack of communication is bound to be exacerbated, however, if the Resident Scientist does not exert extra effort to interact with others.

Strengthening Vegetable Research: Malaysia-AVRDC

The Technical Assistance Agreement (Strengthening Vegetable Research Project) dated 27 January 1984 was signed between the Government of Malaysia, AVRDC and ADB (Anonymous 1984b). The Project supported the efforts of the Malaysian Agricultural Research and Development Institute (MARDI) of the Government's Ministry of Agriculture to strengthen vegetable research and production in Malaysia. The objectives of the Project were similar to those for the Philippines, Thailand and Indonesia as presented earlier.

A resident scientist was recruited by AVRDC and reported for duty at MARDI in October 1984 but resigned from his position in December of the same year. He was replaced by another resident scientist in February 1985 who remained until the end of the Project in November 1986. Both resident scientists were posted at MARDI's Jelan Kebun Station. They each spent about one month in Malaysia familiarizing themselves with the vegetable research production of the country. They were briefed about MARDI's vegetable research program and visited various agricultural agencies and vegetable-growing areas in the country. It was only after this orientation and consultation that the terms of reference of the Resident Scientist were prepared (Saharan 1988a).

The unwritten terms of reference were:

a. To facilitate the movement of plant materials and other germplasm from AVRDC or other sources;
b. To assist the Director of the Miscellaneous Crops Research Division in managing the funds allotted to the Project;
c. To assist the Director in arranging for the visit of AVRDC scientists;
d. To facilitate the sending of MARDI officials for training at AVRDC;
e. To help review MARDI research programs; and
f. To carry out research projects (i.e. evaluation trials of AVRDC materials and other experiments) based on the established priorities of MARDI.

These terms of reference were made known to most, if not all, officers of MARDI, particularly those involved in vegetable research.

The smooth implementation of the Project in Malaysia was primarily due to mutual understanding between the Resident Scientist and the Director of the Miscellaneous Crops Research Division who, in turn, communicated with his officials. The key factor was good communication. The good relationship between the Resident Scientist and MARDI scientists was very evident in the course of this study. In fact his initial appointment of one year was extended for another half year.

Among the outstanding accomplishments of the Project were (Saadaoui 1986, Saharan 1986, Saharan in these Proceedings): introduction of AVRDC breeding materials which were evaluated under several environments in Malaysia; identification of promising lines of soybean (4), mungbean (2) and tomato (5); introduction of several cultivars of different kinds of vegetables such as asparagus (45), broccoli (11), eggplant (29), cabbage (25), carrot (19), cauliflower (25), cucumber (24), garlic (5), lettuce (18), onion (14), pea (7), sweet pepper (31), hot pepper (36), raddish (9), spinach (17), tomato (22) and turnip (1); initiation of a search for resistance to various vegetables diseases; initiation of integrated pest management (IPM) on diamondback moth; and training of MARDI officials at AVRDC.

Issues Raised During Interviews

The most prominent issues raised by persons interviewed in Malaysia follow.

Hiring of Resident Scientist. The experience with the first Resident Scientist, who resigned after two months, was so unfortunate that MARDI officials were concerned about the hiring

procedures for the Resident Scientist. They asked for instance whether the work experience of candidates, particularly in developing countries, had been considered during the selection process. Another qualification suggested by a Filipino scientist was to require resident scientists to have some degree of experience in management in addition to their competence as scientists. Were the appropriate requirements of the host government given consideration (i.e. plant breeder instead of plant pathologist)? Was the host government consulted before the final decision was made?

Type and timing of training. Very likely the host government sends personnel of varied qualifications and would, therefore, require different types of training programs. (i.e. production training, research internship and special purpose training). Failure to recognize this early enough would result in inefficiency and failure to maximize the full benefit of training at AVRDC. Adjustments should be made, therefore, to match the qualification of the trainee so as not to lose his/her enthusiasm. This would also make the training intellectually rewarding and pleasant as well. Concerns were also raised in assigning the trainees solely to junior staff without even meeting the senior staff who happened to be on duty travel at the time of initiation of training. Such incidents may be isolated but should be mentioned because they create a negative impression to the trainees and are embarrassing to the junior staff who appear to have just received the assignment to substitute their superior. Thus, if this is a case of poor timing or an oversight on the part of the appropriate center personnel, extra efforts should be exercised to avoid these occurrences in the future.

Impact of Bilateral Programs on the NARS

The consultant concurs with the recent paper of Jahnke et al. (1986) that "Impact assessment of research activities is a complex task and this is true, in particular, with respect to potential effects of the International Agricultural Research Centres." This is true because the probable causes of these potential effects are usually multiple (i.e. government policy, national discipline, government and public will, IARC, etc.). Thus, it is not simple to quantify the contribution of a particular cause to a particular effect. Impact assessment becomes more difficult, especially for younger centers/programs than older ones, because it generally takes at least 10 years before quantifiable benefits can be measured from a research undertaking which involves the development of a new crop variety. This process can take even longer if variety development starts from the transfer of a useful gene from a wild species to a cultivated variety. For instance the usefulness of the self-pruning gene in the tomato was realized only 26 years after its discovery and incorporation into a cultivated variety. The gestation period is slightly shorter in the case of applied research. In this study the oldest program was from the Philippines which was implemented in 1975-78, whereas the youngest program was in Malaysia which was undertaken in 1984-86.

The approach used in the impact assessment of other centers was adopted in this study, that is the consultant assumed that any improvement in the NARS, with respect to the mandate crops, that can be associated with any activity of AVRDC is considered as part of the impact of AVRDC on the NARS. Based on the interviews, questionnaires and secondary data, the impact of AVRDC on the NARS is in the following areas: generation of technology such as improved germplasm which AVRDC disseminates freely; staff development primarily associated with the AVRDC training programs, and dissemination of knowledge through publications, workshops and symposia.

Generation of Technology

AVRDC has made exceptional progress toward achieving many of the goals in its origional mandate. The Report of the Third External Review (AVRDC 1984) of AVRDC clearly emphasized this, "Among its five mandate crops, Chinese cabbage has been successfully adapted

to tropical cultivation; tomato has been significantly improved in its ability to grow and set fruit under high temperatures and high disease pressures; the architecture of the mungbean has been restructured and the genetic improvements for yield potential increased markedly; the soybean has been tropicalized to yield well under short-day lengths in the presence of a number of biotic and abiotic stresses; and the sweet potato has been improved to produce high yields of nutritional roots for both food and animal feed." In fact, for most persons interviewed, the distribution of parental materials and improved germplasm is the most useful contribution of AVRDC to the NARS. Other promising technologies generated which have slowly gained recognition are a number of innovative management practices for vegetable production.

Germplasm Resources

Just as any other IARC with a commodity orientation, AVRDC has emphasized the collecton and identification of diverse germplasm (current collection totals 27,158 accessions) to serve as the pool from which desirable genes can be used when needed. Many of the Southeast Asian native cultivars are stored at AVRDC and thus it serves as a repository for their valuable genetic resources. The International Board for Plant Genetic Resources has designated AVRDC as the official repository for the world mungbean collection and the Asian/Pacific sweet potato collection. AVRDC is currently in the process of being consulted to hold the world base collection for pepper. Scientists have effectively evaluated and utilized these diverse gemplasm in their improvement programs. Over the years AVRDC has disseminated substantial germplasm of its principal crops in the form of basic genetic resources and improved germplasm (i.e. early and advanced breeding lines) to Southeast Asian NARS (Table 1).

Table 1. Genetic materials distributed to Southeast Asian national programs, 1974-87.

Country	Soybean	Mungbean	Tomato	Chinese cabbage	Sweet potato	Pepper	Others	Total
Indonesia	8,229	4,517	1,217	557	220	8	189	14,937
Malaysia	1,417	1,075	1,597	952	177	54	313	5,585
Philippines	6,073	10,093	10,132	2,865	1,509	28	1,791	32,491
Thailand	9,032	9,743	4,693	2,544	583	72	948	27,615
Total	24,751	25,428	17,639	6,918	2,489	162	3,241	80,628

Source: (Tay 1988).

Advanced lines of AVRDC germplasm are being effectively tested in the NARS throughout Southeast Asia. The testing program has resulted in the more promising materials included in their testing programs.

Promising Technology

Scientists and AVRDC alumni from NARS identified a number of promising technologies which have gradually been adopted in their respective countries. Some of these are the use of plastic mulch in vegetable beds, nylon net covers for raising seedlings, plastic nets/sheets for protected vegetable cultivation, lifting of sweet potato vines to enhance better root formation and appreciation of integrated pest management to control the diamondback moth. Although such promising technologies have not been necessarily developed by AVRDC, the Center has acted as a window to either directly or indirectly introduce this technology to the NARS.

Staff Development

Investment in human resource development has generally provided good dividends because the availability of well-trained and dedicated researchers and extention specialists is a key to

Table 2a. Recommended soybean and mungbean varieties in Southeat Asian NARS using AVRDC germplasm, 1988.

Crop/Variety	AVRDC number	Year released	Country
Mungbean			
BPI Mg2	VC 1163	1984	Philippines
BPI Mg4	VC 2764B	1986	Philippines
BPI Mg7	VC 1973	1988	Philippines
Kamphaengsaen 1	VC 1973A	1985	Thailand
Kamphaengsaen 2	VC 2778A	1985	Thailand
Chai Nat 60	VC 1178	1987	Thailand
Manyar	VC 1089A	1983	Indonesia
Nuri	V 2773	1983	Indonesia
Walet	VC 1163A	1986	Indonesia
Gelatik	VC 1160-22-2B-1-B	1986	Indonesia
Parkit[z]			
Soybean			
BPI Sy4	AGS 73	1985	Philippines
Sukothai 1	AGS 9	1986	Thailand
G 2120	G 2120	1980	Indonesia
Wilis	–[y]	1983	Indonesia
Kerinchi	–[x]	1985	Indonesia
Tidar	G 2120-M	1987	Indonesia

Source: McLean 1988a and NARS. [z]Data not yet available (Hakim 1988). [y]From a cross (G2120 × Orba). [x]From a cross (G2120 × Davros).

Table 2b. Recommanded tomato, Chinese cabbage and sweet potato varieties in Southeast Asian NARS using AVRDC germplasm, 1988.

Crop/Variety	AVRDC number	Year released	Country
Tomato			
BPI Tm-P-1 ("Mapula")	CL 2784-1-1-4	1987	Philippines
SVRDC 3	L 22	1980	Thailand
SVRDC 4	CL 1131	1980	Thailand
Ratna	L 21	1979	Indonesia
Intan	L 33	1979	Indonesia
Berlian	L 15	1984	Indonesia
Mutiara	–[z]	?	Indonesia
Chinese cabbage			
Esperanza	76 M(3)-27	1982	Philippines
Corazon	76 M(3)-35	1982	Philippines
Reyna Elena	Hybrid 62	1983	Philippines
Sagihe	77 M(3)-26	1984	Indonesia
Talaud	77 M(3)-40	1984	Indonesia
Sweet potato			
BPI-SP 1	LO 323	1983	Philippines
BPI-SP 2	CI 693-9	1985	Philippines

Source: McLean 1988a and NARS. [z]From a cross (Gondol × Intan), data not yet available.

the success of agricultural research and development programs. That is why all grants and/or loans in the agricultural sector have always included a strong component on staff development. It is not surprising, therefore, that administrators and AVRDC alumni of NARS perceive any type of training program as an equally significant contribution as NARS receipt of improved germplasm.

AVRDC has continuously trained national technical personnel from many developing countries. To date the Center has trained 72 research and extension personnel under the bilateral agreement programs with the Southeast Asian countries (Table 3). Trainees from the Philippines came mostly from the Department of Agriculture and State Colleges and Universities (SCUs). Those from Thailand represented the universities with a few extension agents from the Department of Agricultural Extension and researchers from the Department of Agriculture. Whereas, all trainees in Malaysia and Indonesia came from national research institutes: the Central Research Institute for Horticulture in Indonesia and MARDI in Malaysia. The higher number of ADB-supported trainees in Malaysia was due to the policy of MARDI to send officers for short-term, rather than long-term, training. There are also 253 persons from the four countries who have been trained at AVRDC through other programs. In this regard the Philippines sent more personnel to AVRDC because of the ability of Filipino NARS to solicit more external support for this purpose.

A summary of AVRDC alumni who responded to the survey is presented in Table 4. The expected 50% response from the alumni surveyed was achieved. This response is considered acceptable since the consultant had less than two months to mail the questionnaires to the alumni. Besides several questionnaires were returned to the consultant due to insufficient and/or change of address of a number of alumni. Nevertheless, the response of AVRDC alumni whose participation in training programs was funded by ADB reached 78% which was much higher than the 49% response obtained from alumni supported by other funding. Alumni from Indonesia failed to equal the enthusiastic response received from alumni of Malaysia, the Philippines and Thailand.

Table 3. National program personnel from four Southeast Asian countries trained at AVRDC, 1987.[z]

Countries	ADB-funded	Other funding	Total
Indonesia	14	49	63
Malaysia	30	10	40
Philippines	14	124	138
Thailand	14	70	84
Total	72	253	325

Source: Castro 1988. [z]Includes trainees at AVRDC headquarters and in the Regional Training Center in Thailand.

Table 4. Distribution of respondents to the alumni survey, 1988.

Country	ADB-funded (no.)	% total per country	Other funding	% total per country	Total (no.)	% total per country
Indonesia[z]	4	33	15	31	19	31
Malaysia[y]	23	92	1	10	24	69
Philippines	14	100	78	63	92	67
Thailand[z]	8	67	31	44	39	48
Total	49	78	125	49	174	55

[z]Two alumni are on study abroad. [y]Five alumni are on study abroad.

Results of survey among AVRDC alumni provide the following inferences:

1. Several AVRDC alumni have acquired advance degrees and other forms of professional advancement after they returned from AVRDC training. Many, especially those from the Philippines, have received professional awards and other recognition for their activities.
2. The majority of the alumni have remained associated with their original agencies where they have been serving as administrators, teachers, researchers and extension specialists.

A number occupy key positions in their organization which suggests the major role they have been playing in policy formulation and implementation of programs in vegetable crops.

3. The two most important contributions of AVRDC to NARS are germplasm distribution and manpower training.
4. There is a general acceptance among the alumni regarding the manner in which AVRDC conducts its various training programs because they are practical and relevant to the conditions in their country of origin in addition to benefiting from the expertise of AVRDC staff.
5. The most useful aspects of the training program are the practical skills obtained in the laboratory and in the field, and field trips to local research institutes, markets and agricultural production areas. They improve their competence and develop more confidence in undertaking research and transferring technology to farmers.
6. The limited application of whatever technology gained from AVRDC has been attributed to lack of funding to acquire equipment and to assume research expenses and the low priority of vegetable crops in their organizations.
7. Less than 50% of those surveyed have maintained contact with AVRDC through correspondence with their former advisers and the AVRDC librarian. However, a very small number of AVRDC alumni have conducted a joint project with the Center or have attended Center-sponsored workshops/symposia.
8. The most serious problems mentioned by many alumni include: (a) lack of communication between alumni and AVRDC; (b) lack of support to alumni to attend Center-sponsored activities; and (c) limited circulation of AVRDC publications.
9. AVRDC alumni surveyed suggested the following recommendations: (a) involve alumni when AVRDC scientists visit country programs; (b) publish a quarterly AVRDC alumni newsletter; (c) hold an AVRDC alumni reunion once every two to five years; (d) provide more fellowships to enable AVRDC alumni to attend AVRDC-sponsored activities and to enable them to undertake graduate studies; (e) restore the sending of AVRDC publications, especially to those researchers who are far away from libraries; and (f) prepare a lecture syllabus for topics included in the training program.

Workshops/Symposia and Publications

In addition to improved germplasm, AVRDC research results are available to the NARS through the holding of workshops/symposia with published proceedings. AVRDC holds major symposia periodically to review the latest developments in the research and development of AVRDC's principal crops and special topics such as rust of soybeans and the diamondback moth pest. Although these symposia are generally open to most scientists, as a rule, key national program personnel from the four countries are always invited to participate (Table 5). AVRDC also regularly invites a national program staff member from each of the four countries to participate in the AVRDC annual Progress and Planning Workshop. This annual Workshop gives the national programs the opportunity to present their country's current research and development in vegetable crops, in addition to involvement in the assessment and planning of the activities.

AVRDC also provides a wide variety of published information in the form of annual reports, proceedings, technical bulletins, international cooperative guides, bibliographies, directories, journal reprints, newsletters and news releases for distribution to libraries, researchers, extension workers, administrators, and others throughout the world. The extent of AVRDC's mailing list in Southeast Asian countries is indicative of its committment to disseminate knowledge to as many users as possible (Table 6).

The increase in the number of libraries and other recipients over the last six years is impressive. Most AVRDC publications are also available at discounted prices from several outlets in developing countries such as India, Indonesia, Kenya, Malaysia, the Philippines and Thailand. Clearly, AVRDC activities have been reaching the region, not only through its improved germplasm and alumni but through its publications as well.

Table 5. Participants from Southeast Asian countries in AVRDC-sponsored workshops/symposia 1977-88.

Symposia/Workshop (place/date)	Southeast Asia				Other countries	Total no. of participants	No. of countries represented
	Indonesia	Malaysia	Philippines	Thailand			
Pre- and Post-Harvest Vegetable Technology in Asia (Los Baños, Laguna Philippines 7-12 Feb. 1977)	1	–	26	4	13	44	10
Rust of Soybeans - The Problems and Research Needs (Los Baños, Laguna, Philippines/28 Feb.-4 March 1977)	1	–	17	2	13	33	8
First International Mungbean Symposium (Los Baños, Laguna, Philippines/16-19 Aug. 1977)	4	6	91	5	33	139	17
First International Symposium on Tropical Tomato (Tainan, Taiwan/23-27 Oct. 1978)	4	3	23	9	90	129	18
The First International Symposium on Chinese Cabbage (Tsukuba, Japan/11-15 Sept. 1980)	1	1	3	2	185	192	20
The First International Symposium on Sweet Potato (Tainan, Taiwan/23-27 March 1981)	3	–	9	2	92	106	23
Soybean in Tropical and Sub-Tropical Cropping Systems (Tsukuba, Japan/26 Sept.-1 Oct. 1983)	8	3	4	11	200	226	29
Soybean Varietal Improvement (Jakarta, Indonesia/21-22 July 1984)	7	1	9	1	11	29	12
Vegetable Improvement Gardening Workshop (Bangkok, Thailand and Tainan, Taiwan/22-26 April 1985)	3	–	4	2	8	17	5
Diamondback Moth Management (Tainan, Taiwan 11-15 March 1985)	7	6	7	12	108	140	20
Second International Mungbean Symposium (Bangkok, Thailand/20-25 Nov. 1987)	5	4	12	86	83	190	25
International Symposium on Integrated Management Practices for Tomato and Pepper Production in the Tropics (Tainan, Taiwan/22-25 March 1988)	4	3	4	4	164	179	33
Total	48	27	209	140	1,000	1,424	

[z]Summarized from AVRDC documents.

Economic and Social Impact of Bilateral Programs

The economic and social impact of bilateral programs are similarly difficult to trace because of the following reasons: (a) except for the Philippines, the bilateral programs are still too young to be fully assessed; (b) all programs are research rather than production oriented in nature; (c) identification of a suitable variety is the first step in any food production program; (d) seed production of identified varieties is still a problem in most countries; and (e) commercialization

Table 6. AVRDC mailing list for Southeast Asia, June 1988.

Country	Library		% increase	Total no. of recipients		% increase
	1982	1988		1982	1988	
Indonesia	14	20	43	174	212	22
Malaysia	17	22	29	196	191	3
Philippines	28	77	175	471	639	36
Thailand	9	15	67	233	269	15
Total	68	134	97	1,074	1,311	22

Source: (McLean 1988)

of AVRDC-introduced technologies is very limited. Despite the above-mentioned difficulties, however, there are good indications of the potential economic and social impact of the bilateral programs to the four countries.

Economic Impact

The most important parameters being used in assessing economic impact include: employment generation (i.e. jobs created by the industy); upward trend in real income of all sectors of the industry (i.e. farmers, workers, processors, traders, etc.). All or any combination of the above are likely to occur only if the technology generated (i.e. new varieties and cultural practices) is adopted by farmers; price policy for agricultural crops and inputs and support services (i.e. credit, marketing facilities, extension workers, research back-up) are made available to the growers. Such conditions vary from program to program.

As indicated in Tables 2a and 2b, a number of AVRDC introductions (accessions or derived cultivars) have been released for commercial production in the four Southeast Asian countries included in this study. As far as adoption of these varieties is concerned, the NARS provided the consultant with some estimates showing the approximate area grown to mungbean and soybean (Table 7).

The impressive figures in Indonesia can be partly explained by the attention given to legume crops in that country. The adoption of legume varieties in Thailand and Indonesia is much higher than in the Philippines. One explanation given is that the new varieties in the Philippines have just been released and no sufficient seeds are available. Besides the local recommended varieties developed by Filipino breeders are still generally more preferred by both soybean and mungbean farmers. The nonadoption in Malaysia is probably due to the limited extent of legume production in that country. Although no exact production figure could be obtained, NARS scientists interviewed were confident that the adoption of these varieties in national legume production could substantially increase yield and income of farmers. New mungbean varieties, in particular, have been repeatedly mentioned in the Philippines as becoming more popularly grown in both upland monoculture (in rotation with corn and rice) and after paddy rice because of their earliness and resistance to diseases.

Table 7. Approximate area grown to AVRDC varieties.

Crop/Country		Year	Area grown (ha)	% of total
Mungbean	Philippines	1988	600	2
	Thailand	1988	16,000	4
	Indonesia	1987	30,000	12
Soybean	Philippines	1988	73	1
	Thailand	1988	10,417	5
	Indonesia	1987	360,000	30

Source: (Legaspi 1988, Sumarno 1988, Srinives and Yang 1988).

The adoption of tomato and Chinese cabbage on the other hand, is quite slow. Again, the reason given is the unavailibility of seeds in the market. Breeder seeds of recommended varieties of tomato are made available to government stations but since there is less emphasis on vegetables, wider extension of improved tomato varieties is relegated to a lower priority. Even with the presence of a fairly good scheme of variety release and distribution as exemplified in the Philippines (Fig. 3) and in Indonesia (Fig. 5), the adoption rate is unlikely to increase if governmental food policy is not supportive of a particular commodity. In the Philippines one-tenth of a hectare is programmed for breeder production of BPI Tm-P1, whereas in Indonesia a decreasing trend in foundation seed production is reported: 450 kg in 1985-86, 304 kg in 1986-87 and 12 kg in 1987-88. The decrease in the seed production efforts of tomato is due to the absence of a tomato production program in Indonesia.

The case of Chinese cabbage seeds is different. It is not only less popularly grown in the four countries but its seed production is more difficult and requires more sophisticated skills than seed production of other AVRDC crops. Attempts were made in the Philippines to produce Chinese cabbage seeds but failed. AVRDC has realized this difficulty and has just published a technical bulletin on *Chinese Cabbage Breeding and Seed Production in the Tropics* to help overcome this constraint.

It appears practical that seed production of tomatoes and Chinese cabbage needs to be undertaken by private seed companies. The consultant believes that this undertaking could be attractive to seed companies considering that there are at least 68,000 ha grown to tomato and a few thousand hectares to Chineses cabbage in the four countries.

The Philippine experience in processing tomato merits highlighting in this study because it is a clear illustration of what can happen if a favorable combination of factors are given for

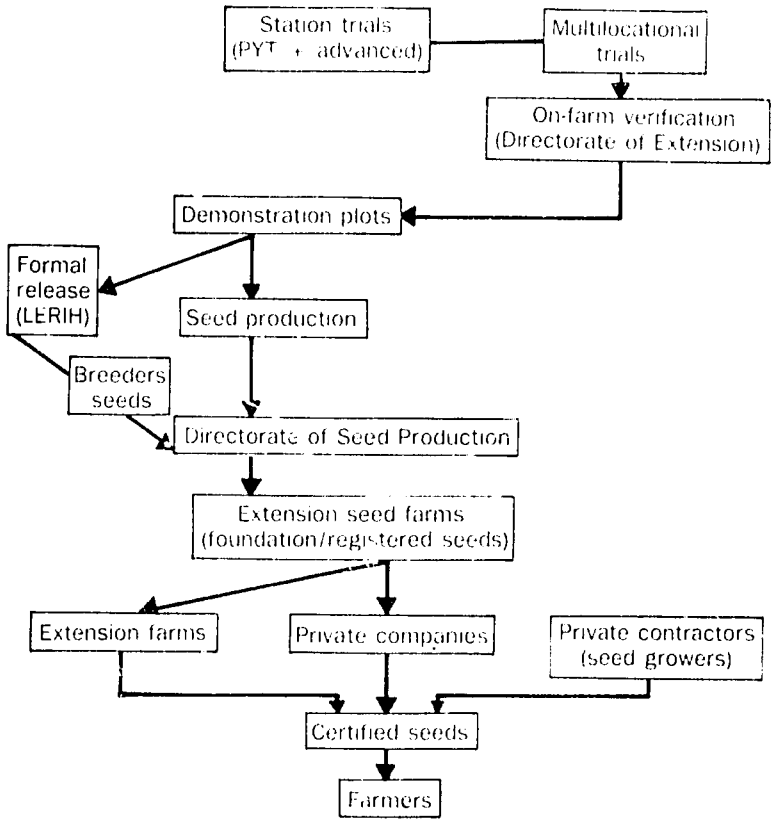

Figure 5. Release and distribution of new varieties in Indonesia (Anonymous 1984c).

agricultural development (Villareal 1988). In this particular case, such factors included alert government officials, appropriate technology, effective change agents, conscientious field workers and farmers willing to participate in a new venture.

AVRDC has been involved indirectly in this venture because the project concept and the origional technology (i.e. varieties and some production technologies) flowed to the Philippine Fruits and Vegetables Industry Inc. (PFVII) in Pangasinan Province from AVRDC via the POP in Los Baños. From the results of a PCARRD-supported project at the Institute of Plant Breeding, the growing of wilt-susceptible tomato following paddy rice has been introduced. This practice allows wilt-suceptible but processable varieties from California and AVRDC to be grown in Pangasinan. In the past bacterial wilt precluded successful production of tomatoes. The first crop of processing tomatoes grown in Pangssinan used some selections from AVRDC's CL 2784 series and the recommended cultural practices from AVRDC since local technologies were nonexistent at that time.

Like the Taiwan model of producing processing tomatoes, the factory provides growers in the Philippines with the following: assured market and support services for the tomatoes (i.e. some form of credit and extension workers). With this arrangement, therefore, growers are encouraged to produce more resulting in excellent yields and high net return per hectare. For instance the PFVII obtain 20 t/ha in 1984, 14 t/ha in 1985 but increased to 28 t/ha in 1986. These yields are not impressive by temperate standards but they are two to three times higher than the Philippine national average and they were accomplished within three years. Moreover, during the 1986-87 cropping season several farmers obtained yields higher than 50 t/ha and some even obtained 70-80 t/ha. The higher yield increases the farmer's income and improves his total farm income since the tomato is an additional crop planted after paddy rice. In 1986 local paste production supplied 32% of the domestic requirement, thus saving precious foreign exchange and providing additional jobs to workers in the manufacture of farm inputs and in the processing of tomato paste.

Social Impact

The ultimate goal of all research and development programs in vegetable crops, particularly in developing countries, is to improve the lives of people, especially the small farmers and the rural poor. One approach to achieve this goal is to increase their income and improve their nutritional status as articulated in AVRDC's garden project (Llemit and Lastimosa 1988). It is perceived that an improvement in the yield level of vegetable crops would result in increasing the income of the farmer and improving his/her purchasing power. The increase in purchasing power will allow the purchase of more nutritious foods, including vegetables for the family. Alternatively the family can obtain its supply of vegetables and other nutritious foods by growing them themselves for home use.

The assessment of social impact, in terms of ameliorating human malnutrition, is most difficult to achieve due to the time limitation and absence of baseline data on the nutritional status of people in specific areas where AVRDC technologies have been transferred. Besides, in order for such an assessment to be carried out it would require cooperation of at least the health, education and agricultural sectors in both private and government agencies. Unfortunately, in this study, cooperation only within the agricultural sector was sometimes even short of expectation. In addition this study was not designed to conduct an in-depth analysis of the nutritional status of the four countries in relation to vegetable production. The impact on the nutritional status is so important, however, that a special project study on this subject deserves to be undertaken.

Summary and Recommendations

Lessons Learned from Implementation of Bilateral Projects

Certain problems have been encountered in the implementation of the bilateral projects from which a number of lessons have been learned. These lessons are pointed out in this section together

with appropriate recommendations meant to minimize mistakes and achieve an efficient and systematized implementation of future collaborative projects.

Project duration. All administrators and scientists involved with the projects felt that the duration of two years was too short to be able to derive full benefits from any project, especially when dealing with the testing or adoption of a technology. A longer duration will enable a NARS to gain more experience in implementing the project when it takes over.

Recommendation. The consultant concurs with the observation of NARS and strongly recommends to the ADB to increase the Project duration to five years.

Project awareness. The responsiblities in the implementation of the Projects are clear as far as the Technical Agreement among the host government, AVRDC and ADB is concerned. However, there were a number of oversights which resulted in some misunderstandings and apprehensions, particularly on the part of local scientists and junior administrators who in general had little knowledge of what was going on. The lack of project awareness between parties, particularly within and outside the organization in the host government, contributed largely to poor communication and inefficiency in the implementation of the project.

Recommendation. AVRDC, through its Office of Information Services, should coordinate with the host government to conduct an effective information campaign about the project prior to its implementation. If possible, the highlights of the project documents should be translated into the local dialect.

Terms of reference for resident scientists. Only TOP had its terms of reference signed by the representatives of the host government, AVRDC and ADB. The other Projects felt that the Technical Agreement and the appointment letter of the Resident Scientist could serve as the terms of reference.

Recommendation. A more specific terms of reference should be developed by AVRDC, in consultation with the host government and ADB, and such terms of reference should accompany the appointment letter issued to the Resident Scientist. In addition, these terms of reference should be made known to all concerned, at least in the immediate organization where the Resident Scientist is assigned.

Recruitment procedures for resident scientists. AVRDC recruits and employs the Resident Scientist in accordance with the Technical Agreement of the Project. The consultant feels that AVRDC has established a well-defined procedure in order to recruit the best qualified scientists to work for the Center. Nevertheless, in two separate instances, the posted Resident Scientists (for the Republic of Korea and Malaysia) stayed on the job for a brief period.

Recommendation. AVRDC should review its recruitment procedure of scientific staff in order to minimize these unfortunate incidents from recurring. One suggestion from the NARS is for AVRDC to look into the experience of the candidates in developing countries and their ability to interact with others, especially those of different cultures. The NARS also feel that resident scientists are assigned to work directly with them and not as advisers or consultants.

Criteria for selection of trainees. The Agreement specified that "the recipients of training fellowships shall be nominated by the Government on the basis of the criteria for selecton adopted by the Government in consultation with the Bank and AVRDC". In this regard only the Philippines has prepared a set of written criteria. The other Projects claimed that they have their own set of procedures in identifying fellowship recipients which apply not only to AVRDC training but to other training as well.

Recommendation. The host government should establish such written criteria to serve as guidelines to all concerned, particularly to project implementers who may not stay long on the job due to transfers, promotions or resignations. It is also one safeguard to assure that only qualified persons are sent for training and thus efficiently utilize whatever funds are made available for the purpose.

Collaboration within and with other agencies. Except in the Philippines, it appeared from this study that the implementing agency of every Project maintained the notion that the Project was for exclusive use by the agency. This was first observed in the trainees sent to AVRDC via the AVRDC funding. For example, all of the 14 trainees in Thailand worked with Kasetsart University; all trainees from Malaysia were officers of MARDI and those from Indonesia were connected with CRIH/LEHRI. The nonparticipation of other agencies (i.e. SCUs and the Department of Agriculture) initially in the training program has been resented by staff from those agencies. Consequently, there was also an apparent lack of collaboration in the conduct of experiments which is unfortunate because in order for agricultural research to serve the agricultural community effectively it is essential that there is a working collaboration among agricultural workers themselves; in this case, between scientists of SCUs and research stations. Naturally, such collaboration is unlikely to happen if it is absent even within the organization.

Recommendation. The consultant strongly recommends that NARS look into this matter very seriously because this lack of collaboration is a serious stumbling block for any agricultural research and development project to succeed.

Provision of local counterparts. The concern for prompt Project implementation due to lack of interest and commitment of local staff and lack and/or slow release of funds has been articulated by the NARS. In several instances the ADB grant had to be rescheduled for expenditures on items which were not originally included in the budget.

Recommendation. The consultant urges the host government to increase funding for vegetable research and for the NARS to carefully select the project coordinator and scientists who are qualified and interested to work on the project. The consultant further recommends that the host government should assure the availability of personnel who will man the project and who will continue the project after the grant is terminated and provide funds to carry out the experiments. The grant should cater to the other research expenses, i.e. equipment, local or foreign travel and training fellowships.

AVRDC staff visits. The NARS are unanimous in expressing concern over the infrequent visits of AVRDC staff to the project and its consequences. Infrequent visits can weaken the already established relationships between AVRDC scientists and national program personnel and discourage establishment of relationships with new ones.

Recommendation. The consultant recognizes the limitation on travel funds and staff time of AVRDC but strongly suggests prioritization in the use of the limited travel funds. The consultant strongly supports the recommendation of the members of the Third External Review Team (AVRDC 1984) to explore monitoring tours for vegetable crops as a means of increasing contacts with national and other international scientists. The real value of such activity in enhancing international cooperation and providing national scientists (both junior and senior) the best training possible are well recognized.

Impact of Bilateral Programs on the NARS

Dissemination of AVRDC-generated technologies (i.e. improved germplasm and management practices), training of research and extension staff and dissemination of knowledge through publications, workshops and symposia are the three most important contributions of AVRDC to the NARS in Southeast Asia.

Economic Impact of Bilateral Programs

The wide acceptance of AVRDC-derived cultivars of mungbean and soybean in Thailand and Indonesia can substantially increase their yields because these improved cultivars are both high yielding and disease resistant. In the Philippines the transfer of the technology for the production of processing tomato has actually resulted in increasing the farmer's income and his total farm income, saving the country's foreign exchange and creating additional jobs to workers in the manufacture of farm inputs and in the processing of tomato paste. The consultant recommends that AVRDC considers conducting an in-depth analysis of the economic impact of AVRDC technology where it has been transferred.

Effectiveness of the Bilateral Program Model

Essentially the model involves the assignment of a resident scientist in the host country, provision of support services including visits by AVRDC specialists and other local support. The Resident Scientist has to determine the best varieties and cultural practices suited to local conditions and requirements and to multiply and distribute the varieties selected to local farmers.

If the identification of the best varieties and improved cultural practices is taken as the measure of the model's success, then the model is a resounding success. It needs a great deal of improvement, however, as far as seed production is concerned, especially in the case of tomato and Chinese cabbage. Although there are positive indications of the usefulness of the program, there is doubt on its effectiveness. For instance, one question asked by administrators, scientists and AVRDC alumni is how cost effective is the model in each host country? They expressed the opinion that while the model successfully identified useful technologies, the program spent more resources relative to the impact of such technologies.

The consultant disagrees with the NARS on this point because the perceived impact on the use of improved varieties has been documented and generally shows at least a 20% to 35% annual internal rate of return on investment. He concurs with them, however, on the issue that the more location-specific problems be dealt with by NARS. For example the transfer of a desirable gene from a wild species to cultivated varieties can be done by AVRDC, leaving the utilization aspect of the newly reconstituted germplasm and its subequent performance trials to country programs. Therefore, while the initial impact of the model could be substantial and cost effective, the model is expected to give less impact in the future because the objectives of the original program (i.e. the testing of varieties) can best be handled by country programs.

Future Role of AVRDC

As the level of trained manpower in developing countries increases, the capability to undertake independent research and development programs also increases. Thus, there is a need to evaluate the type and degree of cooperation between NARS and AVRDC. It is inevitable that similarity of objectives and, therefore, duplication of efforts would occur. Two suggested practical solutions to this potential source of friction are allocation of responsibilities and periodic consultation between NARS and AVRDC. IRRI, for instance, has been conducting Annual Collaborative Research Planning Meetings with several of its partners from all over the world.

Continuing role. There is wide recognition on the competence of AVRDC to continue its role in the following areas: (a) distribution of improved germplasm; (b) high-level manpower training of vegetable scientists; and (c) sponsoring of workshops/symposia together with the collection of literature on vegetable crops which are made available to country libraries and individual researchers.

AVRDC should continue to collect, store and utilize germplasm resources and, as indicated earlier, AVRDC can specialize in making wide crosses and leave the utilization of reconstituted germplasm to national programs. Thus, the development of location-specific varieties is left to the national program. Naturally, AVRDC can also continue to address problems faced by

a large area or a large number of countries. Although it was not expressed by the NARS, the role of AVRDC for genetic resources is a signal for the Center to slowly move to upstream research as well as in the other disciplines (i.e. pest management, agronomy, plant physiology, etc.) and leave the down-stream activities to the NARS with improved capabilities. In any case AVRDC should continue its role of backstopping the NARS and provide a supporting role in identifying problems, preparing proposals, conducting feasibility studies, monitoring projects and evaluating progress.

With regard to the training program, AVRDC's excellent facilities can best be used for training high-level manpower from the national programs. For instance, AVRDC should exert extra efforts in soliciting more funds to allow MS and PhD students to conduct their dissertations at the Center and accept more post-doctoral fellows and sabbatical professors. AVRDC has been conducting lower level training (i.e. production training) since 1976 and should be prepared to transfer this responsibility to national programs which are capable of conducting their own training.

With additional funding the Center can organize more workshops and symposia where scientists from national programs will be invited to participate. It can also expand its publication program and collection of literature on vegetable crops for wider circulation in the tropics.

Contract research. The CIP has effectively used contract research both in developed and developing countries. Contract research has been advantageous both to CIP and to the participating organization in terms of interaction among scientists, generation of more funding, and provision of high-quality, relevant training for CIP junior staff and personnel from developing countries. The consultant strongly recommends that AVRDC explores the application of this concept, especially in the disciplines where it lacks expertise.

Networking. The use of the networking approach has been successfully used by IARCs within their spheres of activities and a wealth of experience has been accumulated which may be useful to AVRDC (Plucknett and Smith 1984, Seshu in these Proceedings). One outstanding example of such a regional research network which could be applicable to a particular vegetable crop for crucial problems like seed production and pest management is the Southeast Asian Program for Potato Research and Development (SAPPRAD). SAPPRAD is a collaborative research and development program in Indonesia, the Philippines, Thailand, Sri Lanka and Papua New Guinea which aims to promote the development and utilization of the potato in the region. The program started in 1982 and in 1987, it was extended into Phase II which will run until 1992. Sweet potato was included as the second commodity of SAPPRAD in Phase II.

The consultant feels that the method of assigning tasks to a participating country is one of the main strengths of SAPPRAD. For instance, the program concentrates on problems which are common to at least three participating countries. Each participating country is assigned to lead in a particular project which it considers important to that country and which it has a comparative advantage vis-á-vis the other SAPPRAD-member countries. Thus, the following projects were undertaken in Phase I: (a) Breeding for lowland potatoes (Philippines); (b) Tropical agronomy (Indonesia); (c) True potato seed (Sri Lanka); (d) Practical seed production (Papua New Guinea); and (e) Storage and utilization (Thailand).

In the third year of the program, a sixth project entitled "Technology transfer" was added. This project aims to identify mature and promising technologies coming from the five initial projects, and from the research systems. The project then undertakes verification trials in all five countries, packages, pilots and disseminates viable technologies through a technology transfer process linked with the national technology transfer systems.

Funding of all projects is done on a 50:50 basis by the individual countries and by a major external donor. In Phase I most of the donor funds were allocated to the five research projects. In Phase II the countries will assume full funding of the research project and the external funds will be used for technology transfer and program coordination.

The other strength of SAPPRAD is in its management. For instance, the program is governed by a policy-making body called the coordinating committee which has the following membership:

one representative from each country who is usually a high-ranking research or agriculture official in that country and one member each from the International Potato Center and the major donor (Australia). Meetings are held by the committee every year with the country representative from the host country serving as chairman. The coordinating committee is assisted by a technical committee which is composed of the project leaders and chaired by the SAPPRAD coordinating scientist. The latter is appointed by the International Potato Center which is the executing agency of the program.

The Technical Advisory Committee of the Consultative Group on International Agricultural Research has prepared a comprehensive document on CGIAR-Supported Research on Vegetables in which it was envisioned that the collaborative research network approach through research contracts will be used in the new initiative in international research on vegetables (TAC Secretariat 1988). In a similar manner, the FAO-RAPA in Bangkok has submitted an intercountry project proposal on vegetable crops to develop a suitable network of integrated regional cooperation to promote research, development and extension of vegetable crops (FAO-RAPA 1987 and 1988). The consultant strongly feels that the network approach for vegetable improvement in the tropics is an effective way to develop close collaboration with national and international programs and that it is of mutual benefit to all parties concerned to collaborate in this undertaking. AVRDC should take the initiative in coordinating such efforts with TAC, FAO and other organizations.

One specific joint effort of the group which it can initially explore is a collaborative network on the crucial problem of ensuring a reliable and adequate supply of seed of AVRDC-derived cultivars which have been released by NARS and other important vegetables in the region. This problem of varying degrees of seriousness has been identified not only in NARS of the region but in all developing countries as well. Regardless of where the program originates, the seed availability problem will always influence the success or failure of any effort to increase vegetable production in the developing countries. The consultant affirms the concern of the members of the Third External Review Team that "Until there is a reliable supply of seed of AVRDC's improved lines available to the farmers for production in those nations releasing them, the mission of AVRDC cannot be considered to have been accomplished" (AVRDC 1984). It is imperative that this aspect be given top priority by all concerned, particularly in AVRDC future activities. It is also essential that the group involve the active participation of private seed companies in this network to avail of their experiences in the seed industry. Besides many lessons have clearly shown that the success of the seed industry, in most instances, depended largely on strong private participation.

The "charity ward" concept. The significant role of unconventional vegetables or the traditional type consumed by the poorer people has been emphasized in several national and international conferences. Nevertheless, to the consultant's knowledge, specific attention and action accorded to this group of vegetables has remained dismally low. It is not a popular crop to most researchers since it does not attract much external funding because of its generally low return to investment and the difficulty of assessing its contribution to vegetable production. It is usually assumed that the economic impact, rather than the social impact (i.e. nutrition), has been the primary basis for funding a research project. It would seem appropriate, therefore, that the "charity ward" approach being used in hospitals to cater to indigent clients be explored for this group of crops. Under this concept a certain percent of the hospital's activities is devoted to charity without expecting any reward or remuneration for its effort. In a similar manner, the Center can probably allocate a certain amount of its resources without really worrying how to justify its actions to its board and donors. In the ultimate analysis, what is important is to provide the service to the poorer sector of the society and the long-term effect of this group of crops to their well being.

Future Impact Assessment

To provide the donor and executing agency with an assessment of a completed or an on-going program is an important practice. The assessment should include:

1. The necessary guidelines in order to refine their future approach. As such the assessment and/or monitoring of program should always be included in its implementation;
2. Establishment of benchmark information and parameters for assessment as early as the inception of the project;
3. Periodic project evaluation and instituting refinements as needed;
4. Assurance of the exact addresses of contacts to be visited in country programs;
5. Early selection and assurance of availability of local counterpart for the consultant who will assess the project;
6. Inclusion of more personal interviews;
7. Allow at least a three-month lead time for the return of completed questionnaires; and
8. Provision of sufficient lead time between initial contact and start of assessment for the consultant.

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The Potential Role of the Asian Vegetable Research and Development Center for Collaborative Vegetable Research in Southeast Asia

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Introduction

True to the old adage that necessity is the mother of invention, networking has become a priority activity in modern agricultural research. Acceleration of technology transfer, cost trimming and improved target setting are considered major benefits of these wide-scale cooperative efforts between scientists, research institutions and nationals. The three major types of networks in modern agricultural research are (1) information transmittal systems, (2) consultation networks and (3) collaborative research networks. It is this type, the collaborative network, in which this Workshop is primarily concerned.

The collaborative network is usually organized to tackle problems of significance to all participants in the cooperative effort; to conduct research that is jointly planned, coordinated and sharply focused; and the sharing of information and technology is generally systematic. The AVRDC has been conducting network-type activities with national programs for over a decade. For example, genetic materials have been shared, feed-back reports of performance have been shared; new lines have been released and established. A more comprehensive and effective program could have been conducted had there been a larger resource base available.

In some ways the start up of a collaborative network is somewhat like preparing for a difficult mountain climb in which each member of the team brings special skills, equipment and unique experience into the expedition. The diversity of vegetable crops represents many mountains, rather than one. Careful assessment must be made as to what mountains are most important; the best method to climb each mountain selected; and how the teams and equipment should be distributed to insure a safe and successful mission.

The role AVRDC may be expected to play in this collaborative network is that of a place where the mountain climbing team may assemble, evaluate its route and determine the most needed equipment to take to achieve success. Our role should be that of colleague, not expert; synergist, not supervisor; and clearing house, not control center.

Overview of AVRDC's Inputs

The brief discussion was prepared to portray the unique expertise, facilities and experience that the Asian Vegetable Research and Development Center can offer to a collaborative research network on vegetables in Southeast Asia. A short overview of AVRDC as an operational institute may be useful.

The research and development activities of AVRDC are multidisciplinary. The three principal programs are each coordinated by a program director; namely, Crop Improvement Program (CIP), Production Systems Program (PSP), and Development Program (DP). The development, disease screening, characterization and field evaluation of germplasm; the development of unique production methods to optimize yield and quality; and the preparation and distribution of

germplasm and its basic information are all intertwined functions of the team approach to research at AVRDC.

Crop Improvement Program (CIP)

The crop improvement activities of this program include the assembly, characterization, conservation, documentation and utilization of germplasm. The Program is comprised of 4 plant breeders, 2 plant pathologists, an entomologist and a plant physiologist. The staff includes 9 senior scientists (PhD) and 21 junior scientists (MS or equivalent).

Production Systems Program (PSP)

The crop management, cropping systems and soils teams address problems of a regionwide nature related to improved methods of production; handling; or to maintain freshness, nutrient content, or other qualitative aspects; and developing systems to assist farmers to integrate vegetables in rotation with staples.

This program operates a continuing evaluation for inclusion of new vegetables in the crop improvement program: vegetables which may be of use to improve the nutrition and income of rural life. The research on nutritional gardens is implemented in PSP.

This program is responsible for the assembly of production technology inputs and information in written and electronic forms to serve the national programs. This group is composed of 4 senior scientists (PhD), 6 junior scientists and a field-laboratory staff of 38.

Development Program (DP)

The Development Program is responsible for the delivery of technological information, the upgrading of national vegetable extension and research programs through training and cooperative programs, and the influencing of policy makers to improve human nutrition or income generation through vegetable production and marketing. This group contains three senior staff members in addition to the Program Director. The consulting nutritionist (PhD), training officer (MS) and educational materials specialist (PhD) are assisted by a staff of eight.

Training. AVRDC offers three different kinds of training programs, ranging in length from a few weeks to several years (when linked to University graduate degree programs).

1. The **research internship** provides specialized training on a topic such as plant breeding, pathology or entomology. In this program the trainee works closely with the researcher or group in the field selected and the time and content are determined by the needs expressed.
2. The **service internship** gives training in how to operate a genebank, seed laboratory, nutritional or soils laboratory, etc. This program is also tailored to the needs of the national program or trainee.
3. The **production training** program is a five-month programmed course on how to grow a specific crop or groups of crops from seed to harvest.

The AVRDC conducts its training courses at headquarters in Taiwan and at the Regional Training Center (AVRDC-Kasetsart University, Bangkok) in Thailand. The Regional Training Center has had a large number of trainees from mainland China and other tropical countries. The Regional Training Center is supported by several international donors and utilizes AVRDC's entire scientific staff for inputs as necessary in lecture, laboratory and counseling situations.

Cooperative program. AVRDC cooperative programs in Indonesia, the Republic of Korea, Malaysia, the Philippines and Thailand provide feedback on the progress of newly emerging

Center technologies. Program staff also work with researchers in national agricultural programs to assist in developing cultivars and crop management techniques adapted to local conditions and cropping systems.

Support Services

Genetic Resources and Seed Unit (GRSU). The GRSU is headed by a PhD germplasm specialist, 2 junior scientists and a laboratory-field staff of 12. This facility contains long-, medium- and short-term germplasm storage, tissue culture and transfer rooms and various seed laboratories. The genebank operates on IBPGR recommended standards and contains 30,000 accessions. GRSU is an outstanding facility for seed technology research and training.

Library. The AVRDC Library acts as an information resource to support the research and training programs at the Center, as well as to vegetable specialists in over 100 countries. At present, library holdings consist of 10,420 monograph titles, 1,085 serial titles and more than 23,000 documents on AVRDC principal crops. The computerized information retrieval system contains the main bibliographic, thesaurus, institution and serial holding data bases with on-line search capability.

Office of Information Services (OIS). OIS is the multifunctional communication arm of AVRDC charged with editorial, document preparation, printing, distribution, art and photographic services and public relations. OIS currently maintains 50 scientific titles of AVRDC in print which are disseminated through its worldwide distributive network. More than 6,000 institutions and individuals in 160 countries receive AVRDC publications each year.

Specific Inputs of AVRDC for a Collaborative Research Network for Vegetables

The AVRDC was born out of a need to assist national programs in the region to improve their vegetable crop production and marketing output. To assist in this effort, the AVRDC has developed a specialized staffing pattern to serve in this backstopping role. Critical mass, a collection of scientists and body of knowledge devoted to a specialized effort, has been recognized as a vital force in scientific advancement. Some countries have only a small number of scientists working on vegetable problems, thus the assembly of scientists, germplasm and technical information at AVRDC provides this critical mass to assist in their problem-solving process.

The specific offerings of the various specialties of the AVRDC are listed for reference. The list of activities each specialty could bring into a network situation could be expanded and explained more fully; but this list is only intended to assist in the planning of network possibilities. Details would follow.

These specialists are prepared and eager to serve in an expanded collaborative network with national program scientists. If selected to serve as coordinators, a more active role as on-site consultants, synergists for information exchange and focal point for interaction between NARS scientists would be expected.

A. Crop Improvement Program

1. Plant Breeding Staff

a. Assist in the evaluation and development of plant breeding research programs.
b. Provision of basic and improved germplasm stocks.
c. Advise on collection, screening and evaluation of genetic materials.
d. Advise on methods of breeding and screening for disease resistance.

e. Advise on specific hybridization techniques.
f. Advise on appropriate seed production technology.
g. Assist in the training of technical staff in plant breeding and seed production methods.
h. Conduct special studies in support of NARS breeding programs.

2. Plant Pathology Staff

The group at full staff would be comprised of a mycologist (fungal diseases), a bacteriologist (bacterial diseases) and a virologist (viral diseases) of vegetables.

a. Assist in the evaluation and development of plant pathology research programs.
b. Assist in identification and diagnosis of vegetable crop diseases.
c. Assist in the development of epidemiological methods.
d. Assist in development of disease survey programs (viruses, for example).
e. Assist in development of host range studies, virus indexing methodology.
f. Exchange indicator plants and antisera in virus detection programs.
g. Assist in the training of technical staff in plant pathology research methods.
h. Advise on methods of disease resistance screening.

3. Entomology Staff

a. Assist in the evaluation and development of vegetable crop entomology research programs.
b. Provide expertise on biology and control of vegetable insect pests (such as diamondback moth, bean flies and sweetpotato weevil).
c. Advise on assessment of damage level and design of control programs.
d. Assist in training in insect parasite rearing, methods of experimentation and literature survey techniques in entomology research programs.
e. Advise on methods of germplasm screening for insect pest resistance.

4. Plant Physiology Staff

a. Assist in the evaluation and development of plant physiology research program.
b. Advise on methods of stress evaluation in vegetable crops.
c. Advise on methods of tissue culture techniques.
d. Advise on analysis and physiological studies of yield.
e. Assist in training in methods of research in plant physiology.

B. Production Systems Program

1. Crop Management Staff

a. Advise on research methods for cultural practices studies in vegetable crops.
b. Advise on research methods on space-time relations in yield complex of vegetables.
c. Advise on water management research methods.
d. Assist in training technical staff in the broad array of techniques which may maximize profit through best management pratices in vegetable production.

2. Cropping Systems Staff

a. Advise on methods for improvement of cropping patterns in relation to space-time-environment.
b. Share detailed vegetable crop data file as background to systems optimization in vegetables.
c. Assist in training technical staff in cropping system research methods.

3. Soil Science Staff

a. Assist in the evaluation and development of soils research programs.
b. Advise on the diagnosis and development of corrective procedures on problem soils in vegetables (pH, nutritional and physical structure).
c. Advise on the research methodology needed to evaluate the stress relationships between crop, soil water, and soil nutrition in vegetables.
d. Assist in the training of technical staff in analytical, diagnostic and experimental procedures in soils research.

4. Consulting Nutritionist

a. Assist in the development of human nutritional assessment programs.
b. Assist in the development of human nutritional alleviation programs.
c. Assist in the general educational programs relating food production to human nutrition.

C. Development Program

1. Training Office Staff

a. Assist in the evaluation and development of training programs in vegetable research and production.
b. Assist in development of training assessment and evaluation methods.
c. Advise and assist in the development of training materials and procedures.

2. Data Base Management

a. Develop and utilize Vegetable International Professional Service (VIPS) to identify needed/available expertise for the region.

D. Supporting Services

1. Chemistry

a. Advise on food quality assessment methods.
b. Advise on analytical techniques in food chemistry.
c. Advise on chemical composition of raw and processed vegetables.
d. Advise on processing properties of vegetables.
e. Assist in training technical staff in food analysis methods.

2. Genetic Resources and Seed Unit

a. Advise on germplasm procurement, storage and handling procedures.
b. Advise on construction, equipping, and maintenance of germplasm storage facilities and seed laboratory.
c. Advise on characterization and evaluation of germplasm methods.
d. Advise on multiplication, conservation and distribution of germplasm methods.
e. Assist in the training of technical staff in seed technology and germplasm handling procedures.

3. Library

a. Assist in the development of a current vegetable research listing and data bank for the region.

b. Assist in development of a research abstracting service for vegetable research of the region.
c. Assist in the bibliographic search for information for scientists in the area (funding limitation exists).
d. Assist in the training in library documentation.

4. Office of Information Services

a. Assist in evaluation of information systems needs.
b. Assist by copublishing needed scientific material in national languages.
c. Assist in training of editorial personnel.
d. Assist in training of the publishing process.
e. Assist in training for effective scientific photography and audio visual preparation.

Summary

This strategic planning workshop promises several valuable outputs for national programs and the AVRDC. A clear definition of the major problems of the region faced by the vegetable industry, vegetable researchers and policymakers should help all of us to target our research programs more effectively, both individually and collectively. Significant problems common to all four countries should be likely candidates for the comprehensive collaborative approach; but smaller network elements may also be needed.

The AVRDC represents a resource base for information, germplasm and training. The staff and management of AVRDC are committed to assisting national programs in vegetables as much as possible within our resource base. This assistance may be in the form of single country, several countries or regional research linkages. This assistance may involve individual disciplines or a multidisciplinary approach.

The AVRDC offers a unique resource to national programs in the development of a collaborative research network. This uniqueness is the concentration of expertise and the close intertwining of the various disciplines that can be brought to bear on a problem. For example, the plant breeders at AVRDC have an effective and extensive genebank at hand. They have a close-knit team of pathologists, entomologists and physiologists to help evaluate biotic and abiotic stresses as new materials are generated. The food chemistry group assists in the nutritional evaluation of new lines. Horticulturists and soils scientists provide ready evaluation of field performance of new genetic materials and help to suggest ways in which output may be maximized. This linkage within the AVRDC is available also to the region in collaborative research programs.

We are dedicated to the same goals as all national programs in the region; that is to help improve the nutrition and income potential of the people living in the humid tropics.

Country Report Summaries

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Introduction

This brief is prepared to highlight the information presented in the eight country reports for the workshop participants during the discussions on future collaborative vegetable research. It is also hoped that this summary, when published, can be used as a quick reference for those who require a general knowledge of the situation and problems of vegetable production and research in the four participating countries but are not able to read all eight country reports. In order to better meet the immediate needs for identifying the common priority areas of the region, a comparative analytical approach is employed here instead of summarizing each of the country reports separately.

Although sweet potato, soybean and mungbean are also principal crops of AVRDC, these crops were not included as vegetables in most country reports and, therefore, are not included in this summary, either.

Table 1 provides some basic information on agricultural and vegetable production in the four participating countries. The agricultural sector still employes half or more of the total population in all of the countries except Malaysia. Vegetable production showed a considerable increase in Indonesia during the period from 1979 to 1986, while a modest growth (11%) and slight decrease (3%) were recorded in Thailand and Malaysia, respectively. An alarming downward trend should not be ignored in the Philippines during the same period. Annual per capita production in the region (from 14 to 60 kg) is still much lower than in developed countries where it is generally in the range from 90 to 150 kg. After the export and substantial postharvest loss which occurs in the tropics are subtracted, the gap in the per capita amount of vegetables consumed must be even larger. The strong need to promote vegetable production and consumption in the region is evident.

Policy Priorities

The governments' vegetable policies in all four countries are mainly focused on farmers' income generation, nutritional improvement of the population, and foreign currency earnings from exports. In the region, as a whole, vegetable production for the export market seems to best attract governmental attention. In Malaysia local production of currently imported items receives a high priority as well. In Indonesia and the Philippines, seed supply problems also receive high priority. Development of a vegetable processing industry is a current policy emphasis in Thailand, while regional specialization of commodities and farm mechanization are being strongly pursued in Malaysia. Indonesian policymakers regard marketing as one of the crucial problem.

Production Constraints

Lack of suitable varieties and quality seed, insect and disease pests, and high marketing/postharvest loss are considered to be the most important constraints in vegetable production

Table 1. Population and vegetable production of four SE Asian countries.

Item	Indonesia	Malaysia	Philippines	Thailand
Population				
- Total (A) (millions)	169.4	15.9	55.7	52.2
- Agricultural sector (B) (millions)	81.1	5.4	27.0	33.1
- B/A (%)	48	34	50	63
Vegetable production				
- 1979-81 (C) ('000 t)	2,429	475	1,025	2,846
- 1986 (D) ('000 t)	3,543	461	796	3,143
- D/C (%)	146[2]	97	78	111
Per capita production 1986 (kg)	20.9	29.0	14.2	60.2

Source: FAO 1988. [2]112% increase from 1,963,387 t in 1975 to 4,170,674 t in 1986 was reported by the country report (Subijanto in these Proceedings).

and marketing in all four countries. High production costs, excess or scarce water supplies and poor extension systems are considered to be the next most important problems depending upon the country. The poor credit system and soil erosion are also identified as major production constraints in the Philippines and Indonesia, respectively.

Research Constraints

Moving the focus to research areas, the shortage of manpower and funds are noted to be the most serious problems in all countries. The manpower shortage is described as a lack of critical mass for vegetable research, inadequate expertise of many vegetable researchers and too diverse involvement of qualified persons in administration, research management, etc. Analytical views on relative strengths and weaknesses among the different research fields of the participating countries were not clearly provided in the papers except for Indonesia. During the discussion period, Thailand and Indonesia appeared to be stronger than other countries in seed production and certain aspects of insect pest management, respectively.

Funds are scarce not only to meet operational costs but also for basic facilities and equipment. For example, in countries like the Philippines where field experiments are often completely destroyed by typhoons, funds for the construction of all-weather greenhouses would be of great value.

Inadequate supply or lack of suitable varieties and quality seed is not only a production constraint at the farmers' level, but is also a serious limitation in research. Pests are also recognized as a factor limiting research. The diamondback moth often destroys experimental plant materials of cruciferous vegetables, making it impossible to collect any data. Viruses and thrips are two other examples of this type of constraint.

The low priority among agricultural fields in research and development budget allocations, the diverse nature of vegetable crops and improper coordination within the national programs are also indicated to be research constraints depending upon the country.

Areas for Collaboration and Priority Commodities

Pest control is the only area in which all four participating countries feel a strong need for collaborative research. Viruses, diamondback moth and bacterial wilt diseases are the most frequently mentioned pests among the specific problems of this category. Germplasm exchange/varietal improvement, as well as seed production studies, seem to receive the next widest support for collaborative research with AVRDC and among the national programs of the region. Postharvest technology, crop management and off-season production are also recommended to be priority areas for regional cooperation by different countries.

Although not always available or not in the same format, information given in the country reports was utilized to identify the important vegetable commodities in the region. The rankings in planted area and in import/export amount were taken into account together with the frequency of appearance in the texts. Tomato, hot pepper, shallot, cabbage (and leafy crucifers), onion, yard-long bean (and other vegetable legumes), garlic and cucumber seem to be the most important in the region.

Desired Role of AVRDC

What role is AVRDC expected to play with regard to regional collaboration on vegetable research? All of the countries unanimously agree on three different areas: (1) provision of raw and enhanced germplasm; (2) generation and distribution of information; and (3) training. In addition to the above areas, AVRDC is also expected by some countries to provide technical assistance, serve as a bridge or help seek funds for the national agricultural research systems.

Plant breeding, seed production and plant protection are identified to be the areas where training is the most needed. Postharvest technology, tissue culture, farm mechanization, crop management and garden horticulture are also mentioned by different country policymakers to be the areas in which training is required. It was also mentioned that training should be provided continuously in order to keep up with the staff turnover in the national programs.

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Agricultural Research Networks — A Model for Success

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Networks link people and organizations involved in activities of common concern and located within a country, within a larger geographic region or across the continents. Today, networks are being used for a wide range of activities. Informal exchange of scientific information and plant germplasm at national level in several countries and at a limited international level before World War II acted as a forerunner to the adoption of the network approach for agricultural research by the international agricultural research centers (IARCs), established under the aegis of the Consultative Group on International Agricultural Research. The role of the various networks coordinated by the IARCs in the exchange and evaluation of improved crop varieties and germplasm and in the crop and soil management research is well established (Plucknett and Smith 1984, Greenland et al. 1987).

The Network Concept for Agricultural Research

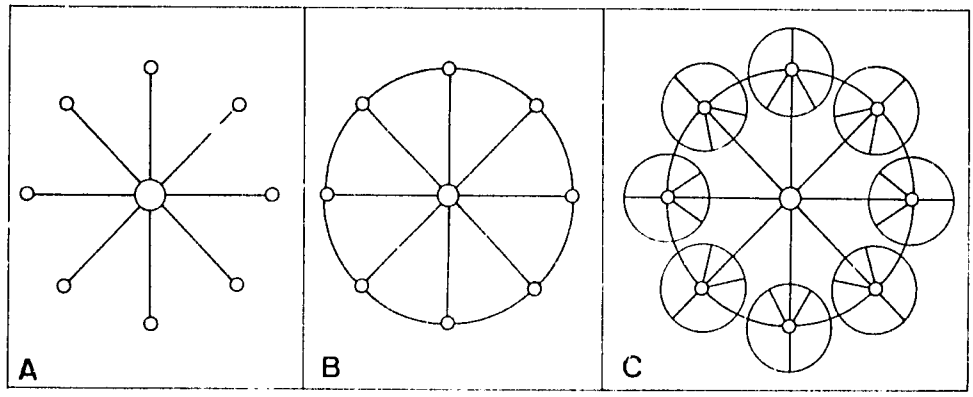
A network approach to attain effectivity in agricultural research is based on the concept of an expanding partnership in learning and problem solving. The merits of such an approach are well substantiated by the conclusion of a recent economic analysis of agricultural research priorities that the contribution of spillover effects from regions where research is conducted to other regions with similar agroecologies and infrastructure is substantial (Davis et al. 1986). The networks serve as inexpensive catalysts for research and provide an opportunity for isolated scientists to work together on common concerns. Working partnerships either on regional or global scales through structured collaboration will, on one hand, boost the efficiency and minimize duplication in research efforts and, on the other hand, help to reduce the costs. The latter is particularly significant in the present context of tightened funding resources.

Agricultural research networks are commonly targeted to the following areas of cooperation:

- Exchange of information on research methodologies and results;
- Collaboration among countries through scientific consultation in planning of research activities and discussion of results;
- Strategic research cooperatives involving selected national agricultural research systems (NARS) and international centers to address specific research problems through joint planning and implementation of research; and
- Global or regional network of research trials to evaluate genetic materials, management practices, cropping patterns, etc. through sharing of experimental material and data and often following a common research format. The trials are jointly planned and monitored.

Baum (1986) described three types of networks (Fig. 1). The first is in the form of a hub (coordinating unit) attached to nodes (network members) by spokes (communication) representing a contact only between the coordinating unit and individual members (Fig. 1A).

The second type connects the nodes with a rim indicating that the contacts also occur between the individual members (Fig. 1B). The third type reflects a collaborative research as coordinated at the hub with information flowing to and from the nodes, within the nodes and between nodes (Fig. 1C).



Types of Networks

Figure 1. The types of agricultural research networks base on hub (coordination unit), spoke (communication between hub and nodes), nodes (network cooperators), and rim (communication among nodes) (Baum 1986).

Ingredients of Effective Networking

Plucknett and Smith (1984) considered the following seven principles for network success:

- The research theme of the network should be clearly defined and realistic agenda developed.
- The problem focus of the network should be common to the systems and environments in which the different participants work.
- The participants should be convinced that they will benefit from membership in the networks in order for them to be motivated to contribute.
- The participants should be willing to commit their own manpower and material resources to network activities for which they accept responsibility.
- The formation and coordination of the network should be funded by an outside donor agency to ensure stability in implementation of the project.
- The network participants should be sufficiently trained and experienced for making effective contributions to the pooled efforts.
- Networks need to be coordinated and guided by strong and efficient leaders who have the confidence of the participants. Because the research capability of the participating institutes varies markedly, collaboration is best served by leaving the leadership post with the strongest participant. For logistic reasons as well as to avoid the possibility of bias to any member of the network, it is probably essential that the coordinators be associated with an international organization.

Greenland et al. (1987) in their analysis of the potential of the international networks made two additional suggestions as follows:

- Support from a developed-country research organization to a particular network member country while strengthening that participant will cause to extend the spillover benefits to other countries.

- Participants must be involved in the management of the network through appropriate coordinating or advisory committees or working groups.

While I am in full agreement with all of the above-mentioned tenets, I would like to add another four principles for network success based on my long years of experience in network coordination, both at the national and international levels. These are as follows:

- The network research or trials at different sites should periodically be jointly reviewed by selected participants to ensure appropriate interaction among the scientists concerned.
- Results of the project should be summarized annually or at other convenient intervals and the reports should be published for distribution to all concerned. This will be helpful in developing follow-up research strategies. Other forms of information dissemination are also important.
- The network trials should be considered as an integral part of the relevant research of the individual national programs and should not operate as parallel programs.
- If more than one related network is in operation at any given location, they should be appropriately integrated to derive maximum benefits and to eliminate redundancy.

International Rice Testing Program — An Example

The International Rice Research Institute (IRRI) presently coordinates three research networks:

- The International Rice Testing Program (IRTP) with a focus on genetic improvement of rice for different ecologies;
- The International Network on Soil Fertility and Sustainable Rice Farming (INSURF); and
- The Asian Rice Farming Systems Network (ARFSN).

These networks were initiated in the mid-seventies and were kept dynamic through incorporation of changes considered necessary from time to time to meet the changing needs of the NARS, as well as to improve the efficiency in addressing the problem focus of collaboration.

IRTP was initiated in 1975 with funding from the United Nations Development Program (UNDP), and coordinated by IRRI. The reasons that prompted the establishment of the IRTP network are explained below.

IRRI, in its first decade, used to name the varieties developed through its varietal improvement program (e.g. IR8, IR20 and IR26). Since these varieties represented an improved plant type (semidwarf), such naming served an important purpose in drawing the attention of researchers, extension workers and farmers in different countries to the merits of a physiologically efficient plant architecture in obtaining significantly enhanced yields. Soon the breeding programs in several Asian countries shifted the emphasis to the new plant type and a series of high-yielding semidwarfs were developed in different countries. While the dramatic yield improvements of the new introductions initially caused great excitement to the researchers and farmers in the various countries, the location-specific problems of climatic and biological stresses and consumer preferences soon came to the surface, rendering some of the introductions unsuitable for a wider adoption. The semidwarfs made an impact primarily in irrigated and favorable rainfed areas. Thus, realizing the diversity of rice ecologies in the world at large, and realizing that the IRRI research farm at Los Baños, Philippines did not represent all those ecologies, IRRI stopped naming varieties to avoid raising high expectations for a broad adaptability. Instead, a mechanism was developed through the establishment of IRTP, for exchange and evaluation of promising breeding lines originating from IRRI, as well as from various national breeding programs and other concerned IARCs and international organizations. Thereby, wider options are provided to individual countries to select lines which are more appropriate to the respective local conditions

and have superior performance potential. This approach was particularly important in the context of a rainfed ecology.

Objectives of IRTP

The specific objectives of IRTP are as follows:

1. To make the world's elite rice germplasm available to rice scientists around the world either for direct use or for use in crosses within their breeding programs;
2. To provide rice scientists with an opportunity to assess the performance of their own advanced breeding lines over a wide range of climatic, cultural, soil and disease and insect conditions;
3. To identify varieties with broad spectrum resistance to major diseases, insects and other stresses;
4. To monitor and evaluate the genetic variation of pathogens and insects;
5. To serve as a center for information exchange on the interaction of varietal characteristics with diverse rice-growing environments in the world;
6. To promote interactions among rice scientists in the world; and
7. To train rice scientists in all aspects of the genetic improvement of the rice plant.

The program, thus, represents an intercountry cooperative effort toward genetic improvement of rice targeted to the many environments in which the crop grows around the world. With an access to a wide range of genetic materials and testing environments, purchase of time is an important dividend for the network scientists in their efforts to develop improved varieties. Further, a broader pool of genetic sources promotes crop biodiversity to reduce vulnerability to pest epidemics. For IRRI's breeding program, IRTP provides the mechanism for evaluation of the genetic material generated with various objectives, and the feedback from the network trials helps in developing follow-up breeding strategies. In other words, IRTP provides a window to IRRI breeders on the problems and requirements of national programs relative to genetic improvement of rice. The flowchart for cooperative testing through IRTP is shown in Fig. 2.

Organizational Aspects of IRTP

The global IRTP has three regional components, i.e. for Asia, Africa, and Latin America and the Caribbean (Fig. 3). The programs at the global and regional levels are guided by separate advisory committees consisting of selected national rice program leaders and the network coordinators at the global and regional levels.

Nearly 1,000 rice scientists from more than 70 rice-producing countries participate in the network. In the organization and implementation of IRTP, the concerned IARCs located in Africa (IITA, WARDA) and Latin America (CIAT) collaborate with IRRI.

Thirty types of nurseries are organized separately for different target environments and for various stresses (diseases, insects, adverse soils, suboptimal temperature and moisture stress). When the program started in 1975, approximately 70% of the total number of test entries in different nurseries were from IRRI and the remaining from the national programs. With the strengthening of national rice breeding programs and with realization of the benefits accruing from participation in a cooperative network, the number of entries from the national programs increased substantially to about 60% as of now.

Seeds of promising breeding lines nominated by different countries are sent to IRRI in small quantities one season in advance for multiplication and subsequent inclusion in specific nurseries. This will, on one hand, reduce the costs involved for the nominating countries in shipping large quantities of seeds required for network evaluation and, on the other hand, provide an opportunity for the coordination unit to check on the purity of the seed during multiplication. This also helps

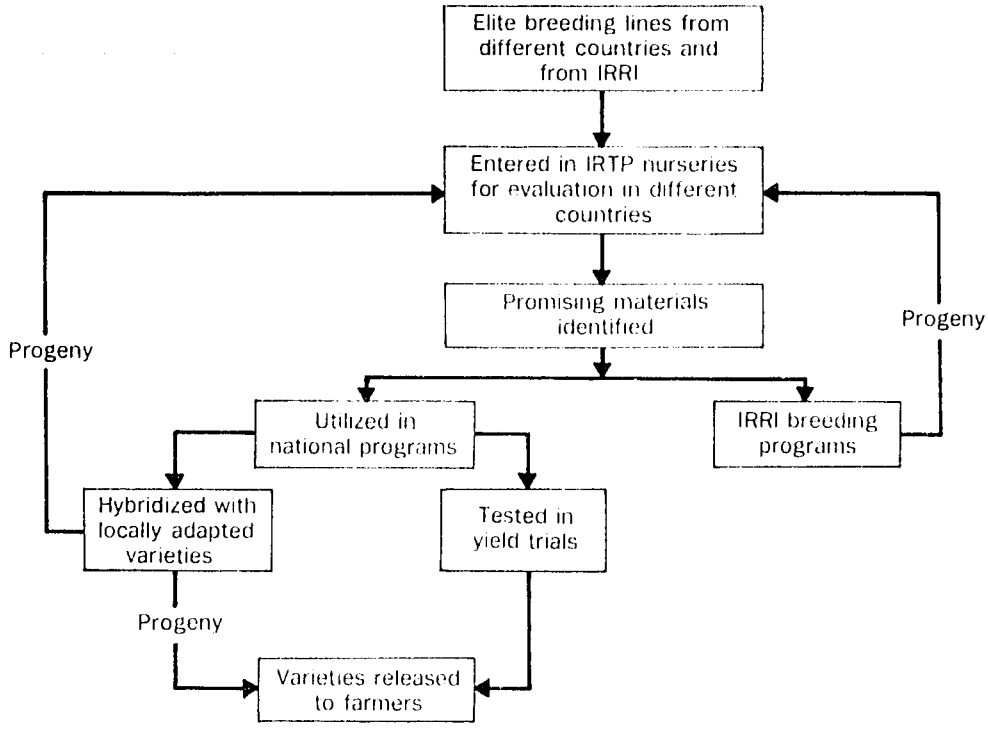


Figure 2. The flowchart for cooperative testing through IRTP.

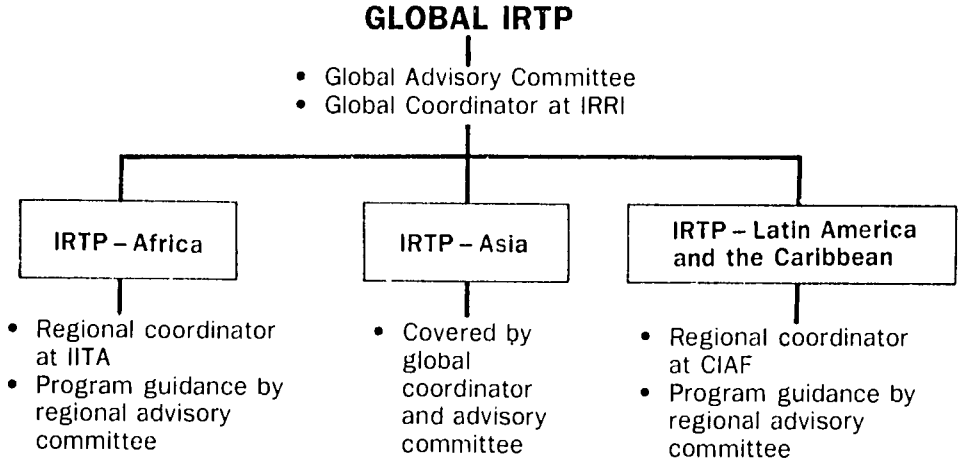


Figure 3. Organizational aspects of IRTP.

in timely processing of nursery dispatch since seed for all test entries is available on hand from the multiplication plots. The seed processing facilities at IRRI have been strengthened to ensure genetic purity as well as seed health.

National program cooperators use their own resources in managing the trials, gathering the data, sending the results, dispatching seed of nominated entries, and travel within the countries to supervise or review the trials.

In countries with structured internal networks, the IRTP nursery requests and other associated aspects are coordinated by the concerned national rice coordinators.

Rationalization of Volume of IRTP Evaluation

It is important for a participating test site, when planning to conduct a trial, to satisfy the relevance of ecological factors, adequacy of human and physical resource facilities and availability of funding. This will provide a sound basis for rationalization of the size of participation. The coordination unit at IRRI has been streamlining the procedures accordingly and some of the steps taken toward this direction are as follows:

- The nurseries are predominantly observational, with yield trials constituting less than 20% of the total of 30 types of nurseries.
- Nurseries are regionalized (as a first step on the continental basis) to increase the proportion of relevant materials.
- Hot spot screening for some stresses is being done for a preliminary elimination of less useful material. In some instances, laboratory techniques are being developed and employed to eliminate entries susceptible to certain stresses (e.g. cold stress) on the basis of isozyme markers.
- Modules are set up within each nursery on the basis of growth duration or ecological adaptation or other criteria such that cooperators can ask for the specific module of relevance to them instead of evaluating the whole nursery.
- When not many new entries are available for an ongoing nursery, it is discontinued until such are available.
- Instead of regular nurseries, special genetic donor kits are supplied to some of the experimental stations with lesser resources.
- Field books for data recording are designed to be user friendly to the participating scientists.
- A 'Standard Evaluation System' has been developed for data gathering and it is continuously reviewed on the basis of the feedback from IRRI as well as from national program scientists such that the quality and reliability of the screening and scoring methods are as reliable and effective as possible.
- Action has been initiated to forge appropriate links between the three networks coordinated by IRRI in order to maximize the benefits.

The above-mentioned improvements certainly ease the cooperators from any undue work load. However, some reasonable amount of time, money and effort are involved in evaluating the nurseries, and these are more than offset by the resulting dividends.

IRTP's total operation has a seemingly large volume because several countries grow rice and most of them participate in the network, and also because rice is grown in diverse ecologies and under diverse stresses. Several nurseries have to be organized to match these conditions. However, the question of high volume mostly applies to the organizational activity at the coordination headquarters at IRRI. Although the total number of nursery tests is large, 40% of the test sites conduct only one trial each, 35% conduct two trials each, 20% conduct three trials each, and only 5% of the sites conduct more than three trials each. Even so, several steps, as mentioned above, have been taken to rationalize the work load of the network scientists.

Forums for Interaction

For an effective participation of scientists from the member countries in program planning, it is important to provide opportunities for them to contribute their inputs and interact with their fellow scientists in the network. The various forums that stimulate such interaction among IRTP participants are as follows:

- The IRTP advisory committee consisting of national rice program leaders and scientists from IARCs meet annually to review the progress of the network trials and formulate future plans.

- The annual International Rice Research Conferences and subject-matter workshops being attended by a larger group of scientists provide another opportunity for interaction among IRTP participants.
- Site visits (monitoring tours) are organized annually (with a focus either on a region or on a specific problem) for a joint review of the cooperative field trials by groups of scientists from different national programs and from IRRI. Such review of field performance provides a useful feedback for follow-up trials as well as for research strategies. Monitoring tours also provide an important mechanism for training of the participating young scientists from time to time. Each monitoring tour has a discussion and planning session on the final day.
- Correspondence and questionnaires provide another important avenue for information exchange and interaction.

Information Dissemination

Reports of network results, joint site visits and other relevant information are published annually and distributed to rice scientists and research administrators around the world. Data from network trials are computerized for speedy retrieval and dissemination of required information to rice scientists in different countries for use in their varietal improvement programs.

Training

Training and staff development relative to rice varietal improvement is an important component of IRTP. Training includes both degree and nondegree components. Most important among the nondegree programs pertaining to IRTP is a four-month course on 'Genetic Evaluation and Utilization' conducted twice each year. To complement formal training, research fellowships are offered each year to appropriate scientists to address specific problems of relevance to varietal improvement. As stated earlier, monitoring tours also serve as training tools for young scientists and as forums for interaction among the participants.

Impact of IRTP

The impact of IRTP is monitored regularly through correspondence, as well as through specific response formats included in the field books.

Several location-specific and high-yielding varieties suited to different ecologies have been identified; some have shown wide adaptability. IRTP tests identified several alternate gene sources for tolerance to various diseases, insects, adverse soils and adverse temperatures. Valuable information was gathered on biotype and race differences in pathogens and insects that attack the rice crop (Seshu and Kauffman 1980) and this helped to identify genes for resistance with location specificity. Information on biotype variation was found to be extremely useful to IRRI as well, to better target its breeding programs to the needs of the various countries. A comprehensive analysis of rice-weather interactions in IRTP trials yielded very valuable information for breeding strategies (Seshu and Cady 1984). One of the outstanding achievements of IRTP is the 'network' itself that brought together rice scientists from various countries that work cooperatively and derive mutual benefits through exchange of research material and information. This cooperative network also helped in developing specific collaborative research projects between IRRI scientists and specific national program scientists from out of the network pool (Heinrichs and Seshu 1981). Furthermore, IRTP stimulated the establishment in some countries of national rice testing networks.

Several hundred entries have been utilized as parents in breeding programs in various countries, as well as in the IARCs. To date, 160 IRTP entries were named as varieties in 47 countries. These originated from 17 national breeding programs and from IRRI, the International Institute of Tropical Agriculture (IITA) and the Centro Internacional de Agricultura Tropical (CIAT).

Some Problems and Cautions

Quarantine bottlenecks occasionally impede the pace of seed exchange. The viability of the seed material is endangered sometimes by slowness in clearance procedures.

Failure of appropriate integration of the network trials with the local research will prevent utilization of the benefits arising from the network participation. The network trials should not run parallel to the national trials, but be a part of the latter.

When not planned realistically, too many research trials with different objectives and from different sources may prove burdensome to the national programs, thereby resulting in a poor research feedback.

Lack of technical expertise and appropriate facilities at a participating site will render the involvement in a network futile.

Conclusion

The complexity of agricultural production systems with the attendant plethora of biological and physical stresses makes it imperative for the scientists within and between countries to join hands in their efforts to augment the agricultural output. This will effectively pool the available expertise and facilities and economize on time, which is the most valuable of the resources. Experience of networking in rice tells that while the agroecological diversity of the crop poses a tough challenge for genetic improvement of the cultivars for the different environmental stresses, the geographical diversity of the crop provides an immensely valuable opportunity for cooperation among countries. Recognition of the benefits of a cooperative effort by the national program leaders and funding agencies will ensure that research networks will continue to play an important role in international agricultural research.

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Designing Agricultural Research Projects for External Assistance*

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Introduction

It is widely recognized that most developing countries lack soundly conceived and well-prepared projects and this impedes the process of development. International funding organizations have repeatedly deplored the lack of projects to fund. Reviews of national development plans often show that programs have been drawn up and goals and targets set, but the means of implementing these programs are not well designed. Since planning aims to identify and select the combination of measures best suited to attain national objectives, planning which does not make provision for well-prepared projects is in effect no planning at all.

This paper attempts to discuss the essential requirements in designing agricultural research projects. It provides insights into the need for external support for agricultural research in developing countries, the changing perspectives of national and international agricultural research, the elements which constitute a well-designed research project and guidelines for preparing research proposals.

External Support for Research

The search for new knowledge and alternative ways of applying what is already known is a vital component of the development process. The contributions that relevant research can make to development have been recognized by Third World countries. The role of research has not always been perceived as clearly as it is today. In the 1950s, in the early days of what has now become the "economic development field", dominant theories of economic growth were so capital centered that they seemed to ignore the effects of everything else. This is itself ironic, as during that period, econometric studies of the source of growth in industrial economies found that changes in capital and labor explained only small fractions of the growth performance. In fact, many of the productivity advances were caused plainly by the improved technology generated by basic and applied research.

The saliency of research has spread quickly to the Third World and it is extended to almost all sectors. Agricultural progress was seen to hinge on supplying new improved technologies. The green revolution program was research intensive, either basic or applied in nature. The developing countries were also confronted by a major requirement for economic and policy research. At the same time, it was clear that they could not rely solely on research from industrialized countries due to differences in environmental conditions such as ecology, resources, characteristics of available production factors and social and cultural values. There were various examples of technologies incorrectly applied and inappropriate solutions introduced into the developing countries. This of course did not imply that research in developed countries was irrelevant for developing countries, but careful judgment of its usefulness in sometimes radically different circumstance was required. In addition, developing countries were faced with intractable problems that were of little or no importance to the so-called developed world.

*The views expressed are those of the author and not necessarily the views of the Asian Development Bank.

Research undertaken in developed countries has been concentrated in sectors that play little role in the economies of developing countries, to build up their capacity to undertake research and to judge the quality and appropriateness of research undertaken elsewhere. This development of research capability implied building of new institutions and providing on-the-job training and opportunities to individual researchers.

It is very difficult to provide an accurate figure of research and development expenditure in developed and developing countries due to the diffused nature of the information. Most studies indicate that, whatever the relative proportion of research and development expenditure in developed and developing countries, the absolute amounts spent in this field by developing countries have increased substantially in the past 20 years. A study covering the data from 67 developing countries estimated that, in 1980, agricultural research expenditures at 1975 prices were US$1,082 million, which is 71% higher than the amount spent in 1975 and 170% higher than in 1970 (IDRC 1987).

There is, nevertheless, an enormous imbalance in the research and development expenditures of the developing countries. A few major countries account for a very large percentage of overall expenditure, e.g. Argentina, Brazil, China, India, Mexico and the Rep. of Korea. Data from the United Nations Educational, Scientific and Cultural Organization (UNESCO) on research and development scientists show that, of the number estimated to be working in the developing countries, 4% are in Africa, 8% in the Middle-East, 23% in South America and the Caribbean and 65% in Asia. It would be pertinent to note that the corresponding figures for overall developing world population distribution are: Africa, 11%; Middle-East, 7%; South America and the Caribbean, 11%; and Asia, 71%. The research and development industry in developing countries now accounts for about US$16 billion/year and yet the broad parameters of this major activity remain largely underresearched and unknown. The equivalent figure for Organization for Economic Cooperation and Development (OECD) countries was estimated to be US$245 billion in 1984 — a further indication of the striking imbalance in this area of global investment.

Role of External Funding

Although national funding is by far the most important, it can be argued that there are compelling reasons for external sources to provide a significant share of official development assistance (ODA) to research. First, research is essentially a long-term activity and countries that are faced, as many of the developing countries are, by urgent and pressing problems of poverty and macroeconomic balance, both in terms of funding public expenditure and in terms of balance of payments, must find it tempting to regard research as an expendable item in their short-term calculations.

Second, research is characterized by major externalities — most benefits of research in one part of the developing world may well accrue elsewhere, and the decisions on research may well require a broad global or regional view of the opportunities and payoff for research on particular areas. Although this must be first and foremost the responsibility of the national governments within a region, donor funds can also often be used to take account of these externalities. This is particularly important for countries with small populations; it may be difficult to create the necessary critical mass for research on particular topics in some of these countries, even though a research problem may be significantly important.

Third, research has an important requirement of foreign exchange for equipment and advanced specialized training outside the boundaries of the individual country.

Fourth, donor funding has played a major role in the development of a substantial set of multilateral research institutions in the Third World and some developed countries under the Consultative Group on International Agricultural Research (CGIAR) system and other affiliated centers. They represent a growing and important new dimension to research and development in and for the Third World and account for a significant share of ODA funding to research.

Donor funds are clearly making a major contribution to research in most parts of the world. For example, a recent report on agricultural research in the Southern African countries belonging to the Southern African Development Coordination Committee (SPARR 1987) showed that more than 50% of agricultural research being undertaken in those countries was externally funded. In many Asian countries more than 40% of the research budget is through external funding. Where external funding accounts for such a major proportion of current research, there must be adequate safeguards to ensure that national priorities are really being followed and at the same time there is adequate provision of building research capacity for the future, so that activity under consideration can be continued even after the termination of external assistance.

Changing Perspectives of National and International Agricultural Research

The International Food Policy Research Institute (IFPRI) projected that the food shortages which the developing countries will face in the year 2000 will be even greater than during the 1970s, and the situation will be more complicated (Mellor 1986). There will be deficits for many countries and a few will have surpluses. However, for the latter the problems of procurement, distribution, price support and income generation to create an effective demand will become equally important. According to IFPRI a trend scenario of the food situation in the year 2000 based on the data from 1961-80 for production and 1966-80 for consumption, projects a Third World production shortfall in basic staple food of about 70 million t. This gap represents about 5% of the Third World's projected demand for basic staple food in the year 2000 and is one-third larger than the food deficit of developing countries in 1980.

This prognosis for the future raises issues relating to the priorities for agricultural research and also associated questions relating to organization and management.

Scientific Concepts and Systems Relationships

When the developing countries in the 1960s started to face massive food shortages in the wake of their mounting population pressures, new concepts were evolved to make agriculture more productive to emerging needs. One of these concepts which has been so highly successful was to reconstruct crop plants like wheat and rice. The dwarf wheat and rice varieties grown under improved agronomic management are the products of these processes of genetic reconstruction.

How far can we go in taking this approach to increasing crop production? Obviously, where crop plants can be grown without much stress, the plant-type concept remains highly valid. It should be possible to develop high-yielding varieties of grain legumes, oil seeds and other crops in the same way as in wheat and rice if the agronomic management can be improved. And indeed, agricultural scientists in some countries are already beginning to do so. However, as long as these crops continue to be grown in their traditional habitats of dry lands under moisture and fertility stress conditions, the breakthroughs may not be easy due to the diversity of environments.

With regard to adaptation, the Centro Internacional de Majoramiento de Maiz y Trigo (CIMMYT) and the International Rice Research Institute (IRRI) have developed wheat and rice varieties, respectively, which can be grown in several different environments. In the 1960s when the national agricultural research systems (NARS) in the developing countries were weak, the approach of developing improved germplasm at the international centers and testing the new varieties widely in the national programs in many different countries was a strategic move, which has paid rich dividends. The concept remains useful for countries in the South Pacific and Sub-Saharan Africa which cannot take up a great deal of research responsibility at this point in time. For many other countries, however, the same need no longer exists. The international centers, therefore, are already beginning to reorient their programs to move more and more into areas of upstream research, leaving applied and adaptive research to the national programs. This move is expected to gather momentum in the next decade.

Increasing Genetic Uniformity of World Agriculture

An important implication of widely adapted varieties is the increase in genetic uniformity of world agriculture with consequent threat of disease and pest epidemics. In traditional farming, hundreds of land races and primitive cultivars help to diversify agriculture and to erect genetic barriers against the spread of pests and pathogens. However, traditional agriculture simply cannot help to meet today's vastly increased food needs, much less the needs of tomorrow. High-yielding varieties, without losing too much genetic diversity, are required. The long-term answer to this problem is decentralized breeding, with the international centers developing their genebanks for disease and pest resistance and other important attributes, and the national programs doing much of the hybridization work, using an important part of the parental material from local sources. The future challenge would, thus, be to combine genes of high productivity into a vast array of new genetic backgrounds. Also, another complicating factor will be the need to develop varieties for widely varying management regimes.

Technology for Stress Environments

In the 1960s when many developing countries were faced with serious food deficits, the most urgent need was to increase food production in the shortest possible time. The strategy, which many of these countries adopted during this period, was to concentrate on lands endowed with favorable features — highly fertile soils having irrigation or assured rainfall. The research approach during this period was to exploit favorable genotype-environment interactions. The plant breeders in addition helped to synthesize genes which can take full advantage of modern farm inputs like chemical fertilizers. It was a highly controlled environment so that most of the stress factors of traditional agriculture did not operate. This strategy has worked well leading to major increases in crop production in many developing countries. More important, it has helped to buy time to organize effective research programs for lands characterized by fertility and moisture stress. It is obvious that many kinds of strategies will be required for these rainfed lands. While genetically improved varieties will continue to have an important role, the emphasis must shift to soil and water management and to agronomic manipulations of various kinds. In other words, manipulation of the environment may well become even more important than the manipulation of genes under harsh conditions.

It has been suggested that agronomic research of this kind is best organized locally as the transferability of results is poor from one location to another. If this is so, then clearly a great deal of work in these priority areas of research will have to be taken up by the national research systems which must be strengthened for this purpose. The international centers should concentrate on the basic aspects of research in water harvesting and soil management and leave the more applied and adaptive research work to the national systems.

Efficiency of Agricultural Production

Much of the scientific basis of modern agriculture is provided by a very limited number of discoveries — at the turn of this century Mendel's work rediscovered studies in the field of mineral nutrition of plants by Liebig in Germany in the last century; the development of plant protection chemicals following the discovery of DDT in the 1940s; and the use of mechanical traction during the last 50 years. The emphasis has been on high productivity rather than efficiency of resource use. With increasing resource constraints in the short term, the developing countries will have to shift to cost-efficient technology in agriculture.

In the longer term, the scientific challenge of making agriculture both highly productive and efficient must be faced. Recent advances in molecular biology hold the possibility of such scientific advance. The tools of genetic manipulation and advances in biotechnology to improve genetic potential, enhance soil fertility and to control pests and diseases with renewable sources of energy hold promise. Clearly, the lead for these studies will have to be taken by the advanced

scientific centers of the developed countries. The challenge is to motivate their scientists and to define clearly the problems to them. The international research centers will have to play a key role and serve as the bridge between the developing countries and the laboratories of the developed countries, if future agriculture is to become both highly productive and efficient.

Sustainability of Agricultural Production

With increasing population pressures on limited natural resource endowments, the sustainability of agricultural production systems will be a major issue of the future. The degradation of forestry and fishery resources, and agricultural lands due to over exploitation is well known. Present land use in many parts of the world, particularly in rainfed and hilly areas, is far from optimum and frequently detrimental to soil fertility and long-term production potential. Restoring the ecological balance and maintaining the long-term capacity of the ecosystem to produce food, feed and fuel to meet the requirements of a growing population will require changes in type and intensity of land use. Such changes need to take into account not only the inherent potential of the soil but also the aspirations of the rural population and market factors. Research on sustainable production will have to be conducted mainly by the national research systems because of the local specificity of the problems. Clearly, a multidisciplinary approach overstepping the boundaries of conventional disciplines of research will be required.

Socioeconomic Research

Modern agricultural technology is perhaps the single most important factor contributing to political and social stability in many developing countries. The earlier criticism that this new technology had helped only the large-scale farmers is no longer voiced so strongly. There is evidence that the small-scale farmers, and more particularly the urban consumers, were also benefited. However, it is true that the advances in agricultural production have not necessarily meant that the nutritional needs of the poorer segments of the society can now be fully met. The problem of lack of effective demand, i.e. demand backed by strong purchasing power, remains. Issues relating to food security, low commodity prices, international trade and protectionism remain vexing. The solutions to these problems rest not so much with the biological scientists as with the social scientists. New policies to deal with these problems are needed, just as much as new research and development infrastructures were needed in the 1960s to accelerate the programs of agricultural production.

Strengthening of National Agricultural Research Systems

Clearly, the national research systems must be strengthened if they are to take up all these new responsibilities. Many developing countries started to pay serious attention to their research services in the 1960s and 1970s in the wake of their desperate food shortages. The idea was to reorganize and strengthen them — to give research a different status altogether in the hierarchy of the government, so that modern science can be harnessed to meet the increasing food demands.

The process of reorganization of agricultural research took many forms but the basic idea was to create a different kind of administrative and management culture. In the traditional organization of these services, they formed part of the bureaucracy of the government, the operational procedures were designed for checks and counter-checks on government spending — to play it safe rather than to take new initiatives and sometimes risks. The response of the larger Asian countries, by and large, has been to create agricultural research councils which took over the research functions of the Ministry of Agriculture. Similarly, the response in many of the Latin American countries has been to create semiautonomous and autonomous national research institutes. If science is to be a hand maiden of development, it has been shown that some degree of autonomy combined with commitment to the needs of agricultural development with a stronger focus on farmers problems is required.

Improved organization and management help to create the potential for a national agricultural system to be effective. Once the potential for effectiveness has been created, we must build on it through the additional dimension of efficiency, and this is done with the help of the research leaders to perform the various functions considered important. Some of these functions include: identification of research priorities and resource allocation, program formulation and implementation, monitoring and evaluation, research coordination, links with the extension service, links with the academic community, staff development and above all links with the policymakers.

Project Design and Formulation

A sequence of project types is in use, with each project serving an important function — experimental, pilot, demonstration and production projects. While production projects often receive major attention, other project types perform important purposes by furthering the discovery and testing of new approaches to development, and by promoting widespread dissemination of results. This section provides guidance on the design and formulation of agricultural research projects. The sequence of project types may not always be required, some steps may be omitted.

The processes of designing a project are to:

1. Identify and state the objectives and related targets which are to be achieved and the scheduled date(s) for their achievement;
2. Identify and summarize the program of interrelated efforts to achieve the objectives;
3. Identify and indicate the role of the project in the program of interrelated efforts, i.e. to determine the functional emphasis it should have and to explain how, and in what context, the project may reasonably be expected to contribute to the achievement of the development objectives concerned;
4. Determine and state the immediate objective of the project, i.e. what the project itself should produce by a particular date; and
5. Establish and describe what outputs it should produce to achieve its immediate objectives; what activities it should undertake, and in what sequence, in order to produce these outputs; what inputs it should have from different sources; and how it should be organized to enable successful and efficient management.

The above processes are iterative and are complementary with each other. One of the more comprehensive design schemes developed is the logical framework used first by the US Agency for International Development (USAID). By providing a means of relating systematically the **inputs** required and the project **outputs** expected to be achieved, the project **purpose** and **goals**, the logical framework provides a consistent means of planning, formulating, monitoring and evaluating projects. Figure 1 details schematically the way in which the logical framework is intended to operate, and Figure 2 is the worksheet used to summarize the salient aspects of project design. The logical framework worksheet provides a conceptual framework for the project designer who is forced to think holistically and systematically about all aspects of the project, i.e. from the provision of inputs to the achievement of the goals of the research work; and the strengths and weaknesses of the project through an examination of the assumptions of the project and the safeguards that need to be built in. For the decision maker, the logical framework worksheet provides a convenient summary of the project, for the project designer an excellent basis for preparing a project proposal, and for the research worker and the project supervisor a convenient basis for monitoring progress and evaluating results.

Preparing a Proposal

The different organizations have their own project proposal formats and it is important to ascertain their requirements when preparing a proposal. However, this section attempts to provide

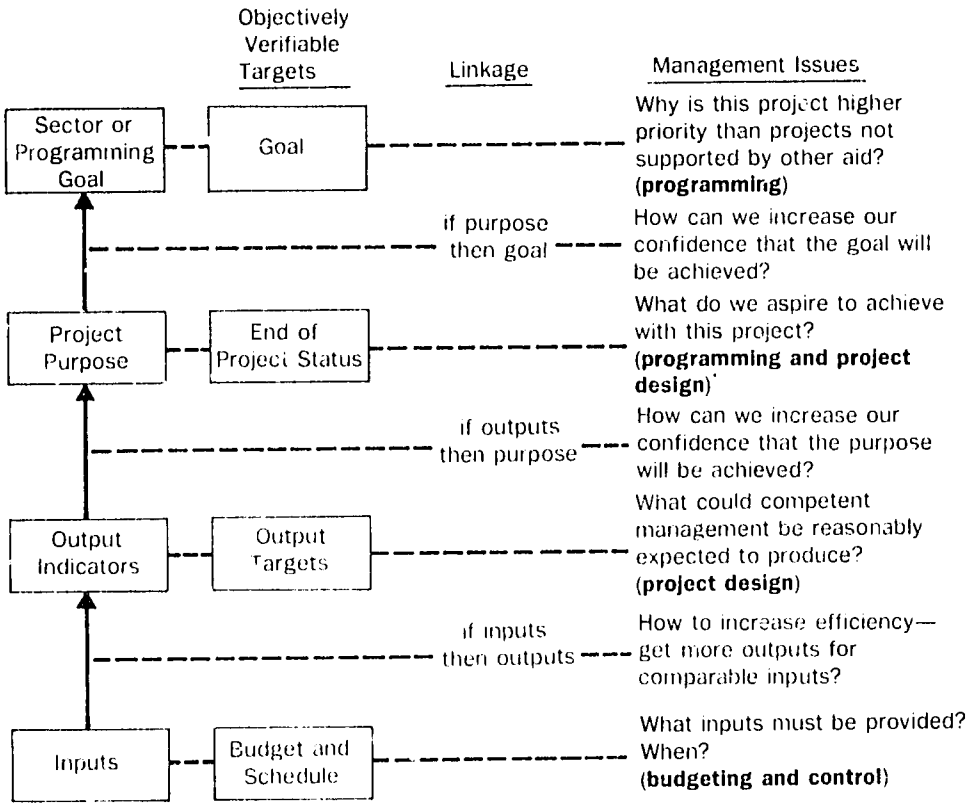

Figure 1. The logical framework of a project.

a synthesis of a number of formats used by multilateral and bilateral agencies in the preparation of agricultural research proposals.

Project Title

It is a short descriptive phrase about the subject of the proposal.

Project Summary

It is a summary statement about the project proposal. The project summary can be supplemented by a logical framework worksheet. This will help in examining the design of the project as well as in monitoring and evaluation. It contains a **statement of the problem, objectives, expected output, cost, financing plan** and **implementation arrangements**.

Chapter I: Background

This section provides the setting of the proposed work. It generally contains the information enumerated below; any additions or deletions to the checklist may be made depending on the relevance of the information for the project under consideration:

1. The sector in the national plan:
   - A summary of the plan's main objective; and
   - Site and importance of the proposed project in the development policy and instruments.

Project Title _____

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Program or Sector Goal: The broader objective to which this project contributes (A1)	Measures of Goal (A2)	(A3)	Assumptions for achieving goal targets: (A4)
Project Purpose: (B1)	Conditions that will indicate purpose has been achieved. End of Project Status (B2)	(B3)	Assumptions for achieving purpose: (B4)
Project Outputs: (C1)	Magnitude of Outputs: (C2)	(C3)	Assumptions for achieving outputs: (C4)
Project Inputs: (D1)	Implementation Target: (Type and Quantity): (D2)	(D3)	Assumptions for achieving inputs: (D4)

Figure 2. Project design summary of the logical framework.

2. The sector in the national economy and performance:
   - Place of the research sector in relation to the country's GNP, budget, external trade and employment.
3. Description of the research system and its components:
   - Structure of the existing research system;
   - Personnel — professional and technicians;
   - State of research conducted in the country, and where appropriate, in the region;
   - Links with the users (advisory/extension services); and
   - Needs to be satisfied, such as:
     - various levels of training and retraining of personnel;
     - scientific and technical information;
     - promotion of local technologies;
     - transfer and adaptation of technologies; and
     - dissemination of research results.
4. Scope for developing research and technology:
   - Potential of existing research institutions;
   - Any links with other countries in the region insofar as mutual support is possible because of the existence of (a) common priorities, and (b) research potential adapted to the region's requirements;
   - Support from the international agricultural research and regional centers and bilateral sources; and
   - Research gaps and need for research support.
5. Rationale of the project proposal: (This aims to describe clearly and precisely how the project fits into the context of sectoral support.)
   - Needs to be satisfied, for instance, adaptation of plant varieties to given environmental conditions; establishment of a national research system in a given sector or merely a network of testing and application stations;

- Selecting the region of operations; existence of a major problem specific to the region, existing research or support infrastructure, etc.; and
- Selecting the type of operation according to earlier considerations, training of scientists and technicians, setting-up of information or documentation facilities, supply of scientific equipment, etc.

6. Description of the chosen region:
   - General characteristics — geographical location and areas involved, regional development, administrative infrastructure and possible means for disseminating research findings;
   - Physical situation, points of particular interest to the project depending on the circumstances — climate, geological structure, soil, water resources, etc.;
   - Sociocultural situation — family, village, social structure (organization, power to take decisions, management); traditions in the field in which research is to be developed (knowledge, technical know-how, tools and instruments); specific responsibilities, where appropriate, between men and women, e.g. for food crops; and
   - Specific, short-, medium- and long-term problems and requirements — they may be extremely varied, in the light of the socioeconomic, cultural and ecological environment, ranging from malnutrition to energy saving, better knowledge, rural food technologies, etc.

Chapter II. Research Institutions

If an international agricultural research center (IARC) or regional center is to undertake the research, the necessary information should be provided on: the history, governance, personnel, research plans and priorities, comparative advantage in undertaking the work, previous linkages with the country/region, budgetary position during the past five years, major activities and accomplishments, and need for financial support. The description should be concise and may be supplemented with appendixes providing relevant data.

A brief description should also be provided of the collaborating agencies, their locations, governance, personnel and facilities, budget, research plans and priorities, comparative advantages in undertaking the work and collaborative work undertaken in the past. The government clearance for the project and collaborative arrangements with international centers should be indicated. An appendix listing related research publications will also be useful to indicate the "state of the art" of the research to be undertaken.

Chapter III: The Proposed Project

Objectives and scope. A clear statement of the overall purpose of the project and a list of the specific objectives should be provided. The work to be undertaken at different locations needs to be clearly stated, e.g. at headquarters and outreach sites.

Methodology. This section describes how each objective will be fulfilled. Sufficient details should be provided to enable a scientific assessment of the proposal. It also includes the plans and work programs of the proposed research project.

Implementation arrangements. This section describes the duration and timetable of the project. It should include the following essential factors: organization and management measures, particularly the responsibilities of the various collaborators; the procedures for the procurement of goods and services; a statement on the capacity to continue with a follow-up research upon completion of the project; a time-phased plan of activities; the time required for staff recruitment and equipment purchases; and a bar chart to indicate the implementation schedule.

Costs and financing plan. The costs broken down on an annual basis during the duration of the project is necessary. The contributions of the funding sources to support the various discrete categories (cost items) of the project should be provided. Inflation rate should also be provided

and indicate the percentage used as the contingency factor. The local contribution, if only "in kind" (salaries, equipment, etc.) should also be costed. A sample budget format is provided for guidance and the following categories are offered as examples (Figure 3):

- **Personnel** – List all project personnel including consultants (if necessary) and the approximate time in person-months which they will spend on the project. The terms of reference for the consultants should be included as an appendix;
- **Equipment and supplies** – List all equipment requirements; indicate specifications and quantities;
- **Travel and per diem** – Indicate reasons and rates. This should be broken down into foreign and local travel;
- **Training** – Local and foreign training activities should be given;
- **Data processing** – Requirements should be noted; and
- **Dissemination of results** – Seminars/workshops, publications.

Each item included above should be justified in the appendix as a note to the budgetary statement.

Sample budget format ('000 US$)

	XYZ Contribution			Recipient Contribution			Total
	Year 1	Year 2	etc.	Year 1	Year 2	etc.	
I. Personnel List and indicate whether full-time or part-time Subtotal							
II. Travel (International & Local) Subtotal							
III. Equipment & Supplies (Itemized) Subtotal							
IV. Training (Overseas & Local) Subtotal							
V. Data Processing (Itemized) Subtotal							
VI. Administration (Itemized) Subtotal							
Contingency (10%)	—	—		—	—		—
Grand Total	—	—		—	—		—

Note: If more than one organization is involved, their respective contributions should be given.

Figure 3. Sample budget format (US$ '000).

Monitoring. It includes information on how the project is to be monitored and what ongoing evaluation and post-evaluation will be conducted. It should include benchmark activities to be undertaken and a list of the agencies involved.

Reporting. It is a statement of the frequency of reporting, the responsibility for report preparation and format to be used, if applicable.

Chapter IV: Justification

This section should briefly state how the results of the proposed research project will contribute to the solution of the problem identified. No quantitative assessment is required. This statement should, in addition, indicate how the results would relate to the operational priorities and the short-, medium- and long-term interests of the concerned sponsoring organizations/agencies.

Suggested Annexes

The following are some attachments to the project proposal which would be useful:

- Supporting data on background section;
- Supporting information on research institutions;
- List of research publications on the problem;
- Project cost estimates;
- Workplan and implementation schedule; and
- Terms of reference of consultants, if applicable.

Literature Cited

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Mellor, J.W. 1986. The new global context for agricultural research — implications for policy. A paper presented during the International Centers' Week, 3-6 November 1986, Washington D.C.

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Discussion: Regional Collaboration Research Potential

T.C. Yap: May I know what are the potential vegetables for the Japanese market from the ASEAN vegetable growers?
M. Kamiya: I listed some items in my paper, but it is difficult for me to point out specific items with import potential in Japan. Instead, I mentioned the importance of meeting importers' requirements, such as freshness and quality.

J.M. Lee: You have indicated that the Japanese market has opened up for the import of vegetables. Now how can you control the price of vegetables in Japan and protect Japanese farmers?
M. Kamiya: Generally the import of vegetables occupies a minor portion of total demand at present, and functions to supplement seasonal shortages. The domestic measures for reducing the fluctuation of market prices of vegetables, which are caused by unstable natural conditions, is the price stabilization system for major items designated by the Central and Prefectural Government. In the near future we may take some steps to adjust the market conditions in case of rapid inflow of products from abroad. However, I think that imported vegetables may meet mainly the demands of the so-called 'eating-out' enterprises (restaurants, etc.) and that domestic production may concentrate on commodities with less competition or strong competitive power for quality.

R.V. Valmayor: Your report lists Singapore and Hong Kong as leading exporters of vegetables in Asia. However, these two countries are not known to be large producers of agricultural products. Do they import vegetables and reexport? Are these two countries in effect net-importers of vegetables?
M. Kamiya: These two countries are not big producers. The data on trade includes data on reexportation. The two countries are net-importers.

S. Jinahyon: Would it be possible for you to forecast the trend of the annual rate of vegetable imports to Japan during the next 10 years.
M. Kamiya: Unfortunately, I can not presently estimate the future growth rate of vegetable imports into Japan. Under the special research project of the Tokyo University of Agriculture on vegetable trade, we are trying to clarify the future demands for vegetables in the Japanese market.

Hashim B.A. Wahab: What will be the effect of vegetable production in China on the vegetable market?
M. Kamiya: At present, Taiwan is a major supplier of vegetables for markets outside of the region. Considering the increasing trend of labor costs in Taiwan and the possible investment opportunities in China, the latter will become a strong competitor. Recently, foreign investments into vegetable industries have begun to shift from Taiwan to other countries like Thailand.

J.-Y. Yoon: You indicated that the resource shift from the farm sector to the nonfarm sector is the cause of decreasing vegetable production in the Republic of Korea in recent years. I believe there are two more factors to be mentioned: commodity change from bulk leafy vegetables to less-productive spice vegetables, and the unreliability of statistics before 1978.

C.L. Luh: (1) The training program should be centered here at AVRDC Headquarters not at any outreach program. Member countries are suggested to select their trainees without fear about China. Entrance visas should be granted by the authorities here if everything has been screened

by AVRDC. (2) Scientists from member countries should be encouraged to participate in AVRDC's program and to give AVRDC a more Asian flavor.

Ma. F.D. Tiamzon: Dr. Batugal's suggestion to put up an Asian Vegetable Journal is a very good idea. However, I have some apprehensions considering that one of the constraints/problems cited by Thailand is that there is not much coordination among research institutions in that country and probably it's the same case in other participating countries. As far as the Philippines is concerned, we have an agency coordinating research all over. This is a strong concern for AVRDC as far as other countries are concerned. AIBA does this and it seems they are having difficulty in retrieving information from the different regions. Dr. Valmayor has the same position.

J.T. Sykes: A wide range of AVRDC's activities and services was presented, including the provision of seed by the GRSU. However, could more be done in the critical area of seed production, in terms of training and specialist advice - also to increase the involvement of the private sector?
G.A. Marlowe: The seed problem is critical. Lines recommended by NARS trials are usually not increased or carried by commercial seed companies, so farmers must use available seed. If some key farmers working with government ledership could help develop these seed needs until significant enough to be attended by commercial seed companies, AVRDC could play a valuable role of training in seed production and handling.

Ma. F.D. Tiamzon: I notice that AVRDC has not had anyone, i.e. consulting scientist or full-time center staff, for a long time, who takes charge of the economics aspect of various programs. As far as I remember when I was still an AVRDC trainee in 1981, Dr. Creighton Peet was then anthropologist who worked part-time as far as economics/marketing is concerned. I believe an economist, who is more of an applied economist rather than a theorist, would play a vital role in the impact of AVRDC programs in the region. No matter how excellent the breeding and crop improvement, cultural management/crop protection programs are, if it's not profitable no farmer in any part of the world would plant any crop if he's not aware of the cost benefit aspects.
G.A. Marlowe: I agree with the questioner completely; and wish I could have remedied this staff short-fall several years ago. The AVRDC needs a farm management type of economist to assist in evaluating the cost-benefit relationships of new varieties and production methods developed as well as helping to assess the impact of AVRDC activities in the countries we serve.

Hashim B.A. Wahab: Will AVRDC be able/willing to overhaul its charter objectives and organization structure to meet the needs and requirements of countries in the region?
G.A. Marlowe: I will certainly advance the suggestions of the policymakers to the Program and Executive Committees of the Board of Directors. I feel that they will welcome these positive quidelines for improvement.

A.A. Asandhi: During the workshop the diamondback moth has been mentioned as one of the most common problems while you have only one scientist. I offer Dr. S. Sudarwohadi to help AVRDC as an AVRDC scientist for 1 or 2 years to help AVRDC to prepare and implement an IPM project.
N.S. Talekar: In our proposed collaborative research on IPM of the diamondback moth, Dr. Sudarwohadi will be involved in planning and execution of the research and development. His input is very crucial to the success of our IPM project.

R.L. Villareal: (1) What is the composition of the network's advisory committee, (i.e. global vs Asian Advisory Committee? (2) How are the activities in the network decided? (3) Who pays for the trials in the network? (4) What is the share of country program in the expense of the network? (5) How effective is the feedback mechanism in getting data from the network

cooperators? (6) How do you decide who will join the joint visit/monitoring tour and who pays for their participation? (7) Do you conduct a regular training program for prospective network participants?

D.V. Seshu: (1) The Advisory Committee is composed of selected national rice program leaders. They are nominated by the concerned national authorities. (2) Through joint planning, the Advisory Committee provides the guidelines for program planning. (3) Network trials are conducted by different national programs using their own resources. (4) It is difficult to quantify, but national programs provide significant inputs: 90% of the trials are conducted by NARS and 60% of the test entries are provided by NARS. (5) The feedback is very significant and many factors have contributed to that; joint site visits, well-designed field books; effective screening and scoring system (standard evaluation system) jointy developed; entry utilization survey, etc. (6) Monitoring tour participants are selected by concerned national programs on the basis of criteria provided by IRRI; funding is by IRRI (UNDP grant). (7) The International Rice Testing Program (IRTP) is associated with a four-month training course twice each year in 'Genetic Evaluation and Utilization.' Monitoring tours also serve as a mechanism for young scientists to participate.

J.-Y. Yoon: You have shown different ways for narrowing down the number of entries for certain particular testing sites. Do you group your candidate entries beforehand? If so, could you kindly let us know more about how this is done?

D.V. Seshu: At the time the entries are nominated by different countries, they provide relevant particulars of their lines through completing a form specifically designed for such information. This helps to classify the material on a first approximation basis.

Ma. F.D. Tiamzon: I have examined a book on the functioning of the ADB but I didn't have the chance to go into it in detail. There are two forms of ADB funding indicated: either a grant or a loan, both for regional as well as for national programs. How can a project be qualified for a grant rather than a loan. I believe developing countries or those in the Third World would prefer a grant.

N. Amerasinghe: The Bank considers technical assistance projects up to US$600,000 on a grant basis.

Working Group Recommendations

Working Group Recommendations

Romeo T. Opeña
Plant Breeder and Program Director, Crop Improvement Program, Asian Vegetable Research and Development Center, P.O. Box 205, Taipei 10099

The country reports presented by the NARS delegates during the first two days of the workshop and the results of the AVRDC mail-in survey of the NARS scientists in Southeast Asia clearly indicated that serious shortfalls in four principal areas of vegetable research are strategically common among the region's NARS. These research fields are as follows: **varietal improvement, pests and disease control, crop production methods** and **seed production technology** (Table 1 and Fig. 1). Although postharvest technology was not identified by NARS representatives from Indonesia and the Philippines, experiences of AVRDC scientists and discussions during the workshop between AVRDC and the NARS indicate that research gaps in postharvest technology exist, although they may not necessarily be of equal importance as the gaps in other research areas.

In addition to the technological gaps, there were institution-related or nonbiological constraints, of which the most important were as follows: **marketing problems; lack of research funds; and lack of trained manpower.**

In order to effectively address the above constraints, the participants to the workshop were divided into four working groups as follows: Group A — Germplasm and Seed Production; Group B -- Pest and Diseases; Group C — Other Important Crops of Southeast Asia; and Group D — Policy and Organization. The tasks of these working groups are to further discuss the major problems and to jointly formulate strategies in vegetable research and development for future implementation by the region's NARS. The major recommendations developed by the first three technical working groups are discussed below. The recommendations of the Policy and Organization Group are given separately (see Section B, also below).

Major Recommendations by Working Groups A-C

Establishment of a Collaborative Vegetable Research Program in the Region

There was general consensus among the NARS represented in the workshop that engaging in partnership research offers distinct strategic advantages. To this effect, the NARS delegates encouraged AVRDC to develop a proposal on a collaborative program of vegetable research among the NARS based on the recommendations formulated by the various working groups.

Priority Commodities

The commodities that were accorded high priority by the NARS representatives during the collaborative workshop were **tomato** and **pepper** among AVRDC's principal crops. Sweet potato and the two leguminous crops of AVRDC, namely soybean and mungbean, were excluded from consideration because of already on-going collaborative networking plans.

In addition several vegetables not currently addressed by AVRDC research but considered strategically important in Southeast Asia were also given high priority in future research thrusts by the NARS. These vegetables, ranked in the order of importance to the NARS, are listed in Table 2.

Table 1. Constraints to vegetable production and research in the Southeast Asian NARS.

Constraints	Indonesia	Malaysia	Philippines	Thailand
Biotic constraints				
Seed quality and supply	+[z]	+	+	
Pests and diseases	+	+	+	
Lack of suitable germplasm	+	+	+	+
Poor crop management		+	+	
Postharvest losses		+	+	
Abiotic constraints				
High cost of production	+			
Technology transfer	+		+	
Marketing problems	+	+	+	+
Environmental stress	+			
Lack of funds	+	+	+	+
Lack of trained manpower	+		+	+
Lack of research experience	+	+		
Lack of institutional support		+	+	
Lack of credit facilities			+	
Lack of collaborative research				+

[z] + indicates the area is considered as a major problem.

Table 2. Strategically important vegetables of Southeast Asia which are not AVRDC principal crops.

Crop	Rank	Crop	Rank
Garlic	1	Asparagus	6
Onion (bulb)	2	Eggplant	7
Yard-long bean	3	Green peas	8
Shallot	4	Pumpkin	9
Cucumber	5	White potato	10

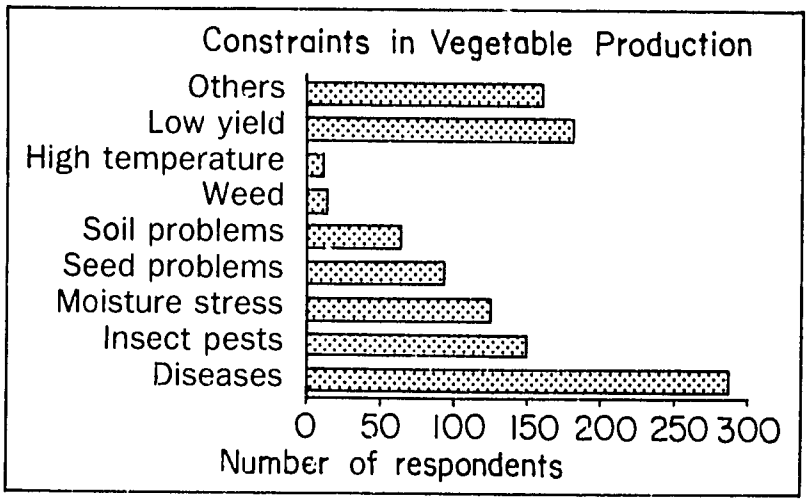

Figure 1. Specific constraints in vegetable production reported by SE Asian vegetable scientists in a regionwide survey.

Priorities for Research and Development

The major research and development activities that were accorded high priority by the NARS delegates and envisaged for implementation by the network in its first five years of operation are itemized below.

Exchange and evaluation of improved germplasm. It is recommended that the NARS' program of evaluating improved germplasm of tomato, pepper and other strategic vegetables in the region be strengthened.

International disease nurseries. Major diseases, specifically bacterial wilt of tomato and viruses of pepper, require international nurseries that would help elucidate strain differentiation, enable the training and provide hands-on experience to NARS' personnel on the nature of the diseases and their symptomatologies, and allow the NARS to evaluate a wider diversity of genetic materials.

Technology transfer of integrated pest management techniques. The national programs expressed urgency in developing and/or transferring integrated pest management technology (IPM) for control of vegetable pests. At this time the IPM technology for the control of diamondback moth of crucifers is ready and will receive priority in the network activity.

Information build-up and dissemination. The enhancement of AVRDC's role as the region's "broker" for technical information on vegetables (through an expanded Tropical Vegetable Information Service or TVIS) was recommended by the NARS delegates. In this capacity AVRDC will serve as the clearing house of information on vegetable technology, with special emphasis on technology relevant to the research and development thrusts of the network.

Major Recommendations by Working Group D

The major topics that were discussed by Working Group D — Policy and Organization — were as follows: goals of AVRDC; the strengthening of AVRDC-NARS and NARS-NARS relationships; technology transfer; and basic organizational mechanics of a potential collaborative research network in the region. The following recommendations were developed by the group.

Research Activities

The NARS' policymakers recommended that AVRDC sustain its research activities on crop improvement, crop production and crop protection. Moreover, the group suggested that research activities on utilization be strengthened and that a significant capability on postharvest handling research be developed.

Structure and Organization

The NARS representatives felt that the countries in the region should have representation in the research planning process of AVRDC so that AVRDC's research would be properly sighted to its target. The suggested alternatives to achieve this goal include the following: restructuring of the AVRDC's program subcommittee to include representative(s) from the countries of the region, and setting up of an advisory technical committee to help steer the direction of AVRDC research. Because of budgetary constraints, the latter was not considered feasible at this time; therefore, the first alternative was highly recommended.

AVRDC:NARS and NARS:NARS Relationships

The following recommendations were developed to foster the relationships among the vegetable research entities in the region.

- AVRDC should conduct more basic research to back up the NARS program to solve the major problems that are common to all countries in the region, e.g. virus research, biotechnology, etc.
- AVRDC should continue to assist in the assembly of scientists to discuss common and major problems.
- The communication between AVRDC and the researchers within the national scientific community of the region should be strengthened through the following means: publication of a regional research update; and inclusion of a training alumni corner in AVRDC's Centerpoint newsletter.
- AVRDC should continue to link with the different member/participating countries through the national research coordinating body, i.e. PCARRD — the Philippines, AARD — Indonesia, MARDI — Malaysia, and in the case of Thailand, through a special coordinating committee.
- AVRDC should conduct an assessment study on the impact of its training program for vegetable researchers in the Asian region to determine if there is a need to change the focus of the training program.

Collaborative Vegetable Research

The Southeast Asian NARS strongly expressed their interests to work collaboratively on common problems, either on a commodity or disciplinary basis. Each country also expressed intent to take the lead role in specific area(s) of research in which it has comparative strengths.

Funding for Collaborative Research

The Southeast Asian NARS recommended that AVRDC explore the possibilities of external assistance to support collaborative vegetable research projects, i.e. AVRDC should act as a facilitator in the establishment of bilateral programs between the donor agencies and the participating member countries.

Participants

Following is a listing of the participants who attended the Workshop on Collaborative Vegetable Research in Southeast Asia, held at AVRDC from 1-6 August 1988.

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